Heating Piping & Air Conditioning

AUGUST 1955

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INDUSTRIAL • COMMERCIAL • INSTITUTIONAL • PUBLIC BUILDINGS

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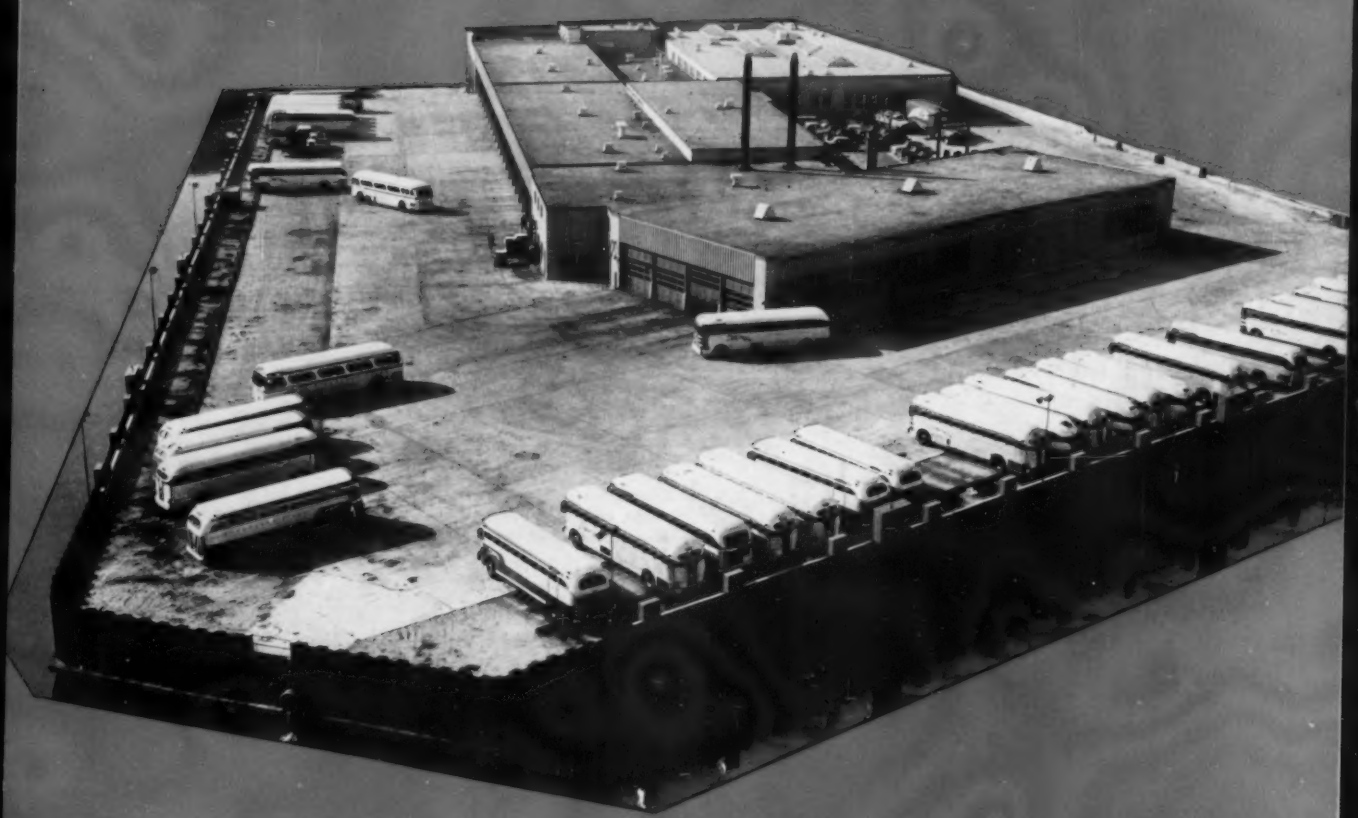
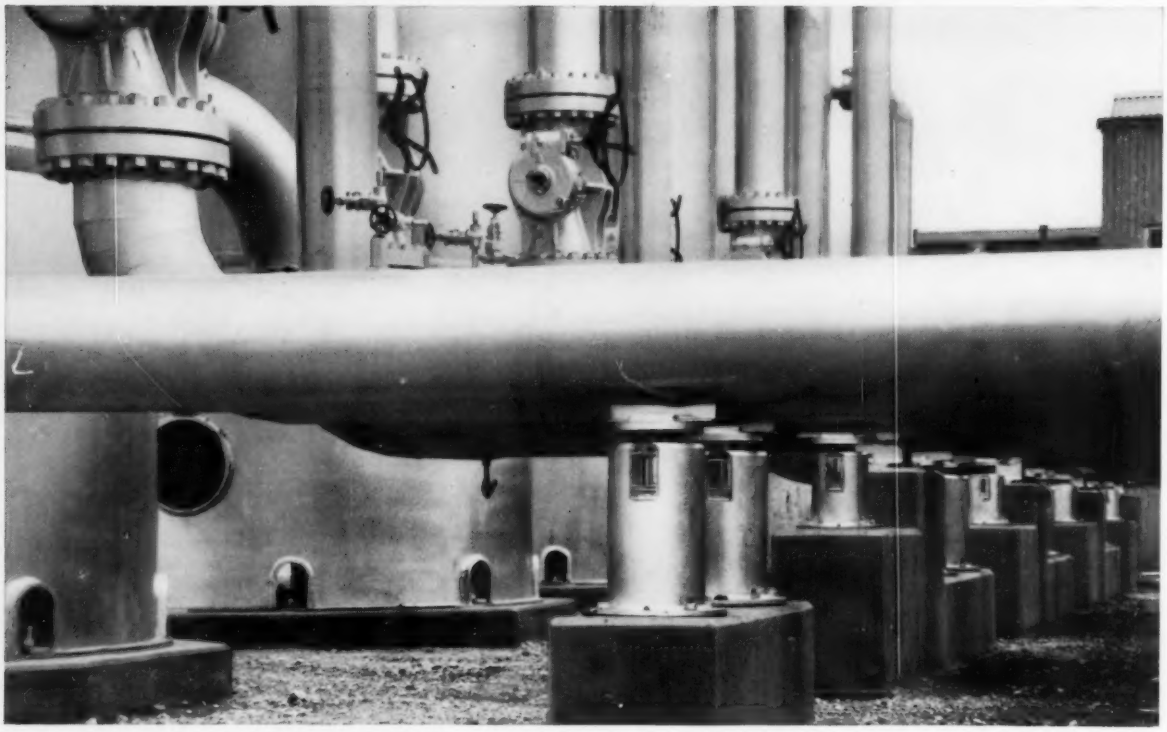


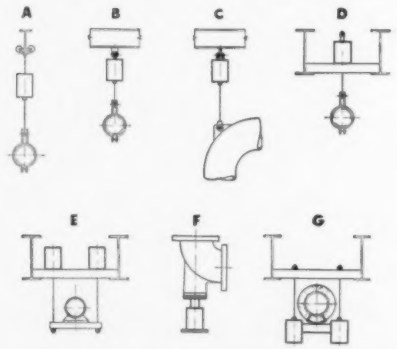
"Piggy Back" heating system with perimeter heat exchanger stations serves buses in outdoor storage. System utilizes hot water from the heating boilers in the main service building . . . 89



For *flexible* support of piping

Grinnell Pre-Engineered Spring Hangers

AVAILABLE IN 7 TYPES FOR THESE TYPICAL APPLICATIONS



(Type A) Rod threaded to top cap (Type B) Furnished with single lug (Type C) Two lug style (Type D) Top adjusting (Type E) Adjustable top and bottom (Type F) For base support (Type G) Trapeze assembly.

The Grinnell Pre-Engineered Spring Hanger was developed after years of experience in analyzing the problems of flexible pipe suspension systems. It is *pre-engineered* to minimize changes in supporting force over total range of movement. Consider these outstanding features:

- **Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.**
- **Precompression* assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.**
- **Solid steel casing protects spring from damage and weather. Guides assure continuous alignment and concentric loading of spring.**
- **18 sizes available from stock for load ranges from 53 lbs. to 12,000 lbs.**
- **Available in 3 spring lengths for travel ranges of 1¼, 2½, and 5 inches.**
- **Installation is simplified by integral load scale and travel indicators.**

***Precompression is a patented feature.**

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
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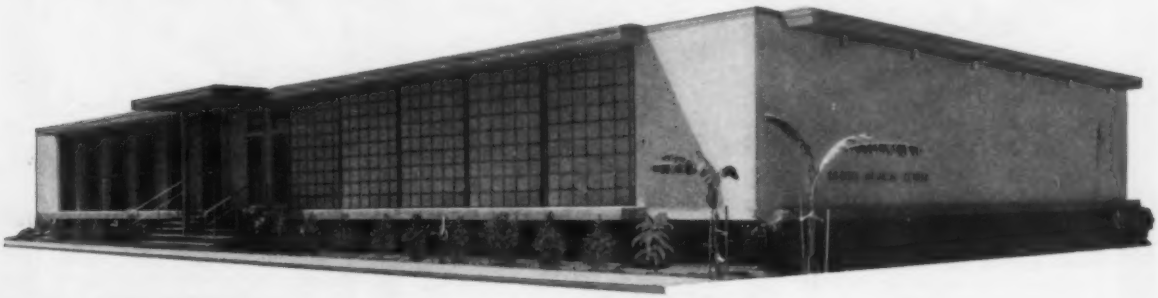
UNUSUAL HANDLING OF SUPPLY AND RETURN AIR SAVES MONEY FOR TEXAS MEDICAL CENTER



usAIRco

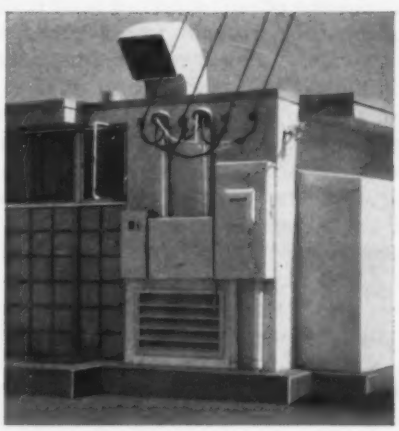
central station RK and duct type gas heaters provide year around conditioning

In addition to eliminating extensive piping runs and lowering labor costs at the new Olmos Medical Center, usAIRco's central station RK requires no roof cooling tower, thus preserving the modern lines of the 48-room San Antonio, Texas structure.

A compact usAIRco RK-25 containing all the elements of a built-up system—air conditioning section, compressor section and water saving evaporative condenser—is located in the indoor equipment room at the rear of the building. Two main supply ducts lead from the equipment room down the center of each double set of offices separated by a center hallway the length of the building. A short take-off from either side of each main duct distributes conditioned air to the individual offices by means of a two-way high wall discharge. The same system furnishes heat in winter, with a usAIRco gas-fired heater in each main supply duct.

Return air grilles are located in each room and in the floor of the hallway, as shown in the top picture at right. A return air plenum extends under the entire floor area of the building. Lower picture of rear of building shows how air is returned to the RK through a chase. The goose-neck exhaust and louvered grille fresh air intake seen in this picture, serve the evaporative condenser.

The Olmos Medical Center was designed by Cerf Ross Associates, architects. The air conditioning system was engineered by Martin E. Staley and installed by the C. H. Dillard Company.

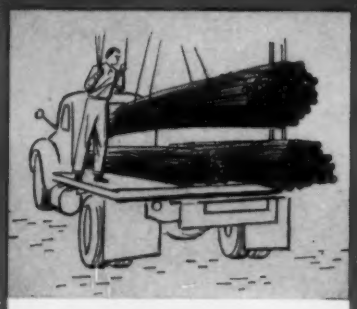


For RK literature write R. I. McLain

UNITED STATES AIR CONDITIONING CORPORATION

MINNEAPOLIS 14, MINNESOTA • *Export: 13 E. 40th St., N.Y. 16, N. Y., U.S.A.*

usAIRco
10 YEARS OF AIR CONDITIONING

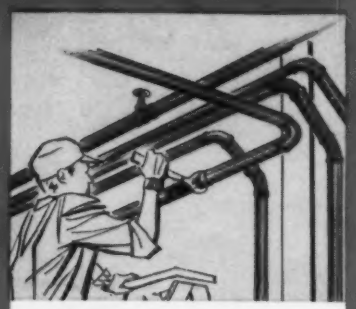


1. Cost of Pipe

The important thing about this cost is that it represents only *one small part* of the piping picture and should not establish the only pipe comparison guide.

2. Cost of Installation

This cost generally represents the *major part of the piping investment* and includes labor, fabrication, valves, fittings, covering, and overhead.



3. Cost of Maintenance

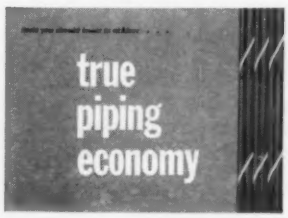
This is the money paid to keep the piping system in operation as long as the need for it exists. The amount spent depends largely on the quality of pipe used.

3 IMPORTANT COSTS THAT SHOW WHY WROUGHT IRON PIPE PROVIDES TRUE PIPING ECONOMY

This breakdown of piping system costs underscores the reasons why wrought iron pipe users enjoy maximum piping economy even though they pay more, *initially*. These users know that they buy an *installed piping system*, not just the pipe. And because the greatest cost of this installed piping system is in labor, valves, fittings, fabrication, covering, and overhead, the difference between the cost of the wrought iron installation and what a low-first-cost pipe installation would have been, shrinks to an insignificant amount in the cost of the *total piping contract*.

But still more important to the plans and pocketbooks of wrought iron pipe users is the Cost of Maintenance. One user put it this way. "A wrought iron installation is like having money in the bank." He was simply expressing wrought iron's longer service in terms of money saved in repairs, replacement, and maintenance. There's no doubt about it . . . when you consider the three costs, you can buy the best—wrought iron—and get a bargain at the same time.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. International Division: New York, N. Y. *Available throughout the world.*



Write for Booklet

The booklet, *True Piping Economy*, gives detailed information on the cost facts presented here, plus many others. You will find it a valuable guide in placing pipe selection emphasis where it will profit you most.

BYERS

CORROSION COSTS YOU MORE THAN WROUGHT IRON

WROUGHT IRON

TUBULAR AND HOT ROLLED PRODUCTS

ELECTRIC FURNACE QUALITY STEEL PRODUCTS

Heating Piping & Air Conditioning

Vol. 27 No. 8

(with which is merged the Aerologist)

DESIGN, INSTALLATION, OPERATION AND MAINTENANCE IN INDUSTRIAL, COMMERCIAL, INSTITUTIONAL AND PUBLIC BUILDINGS

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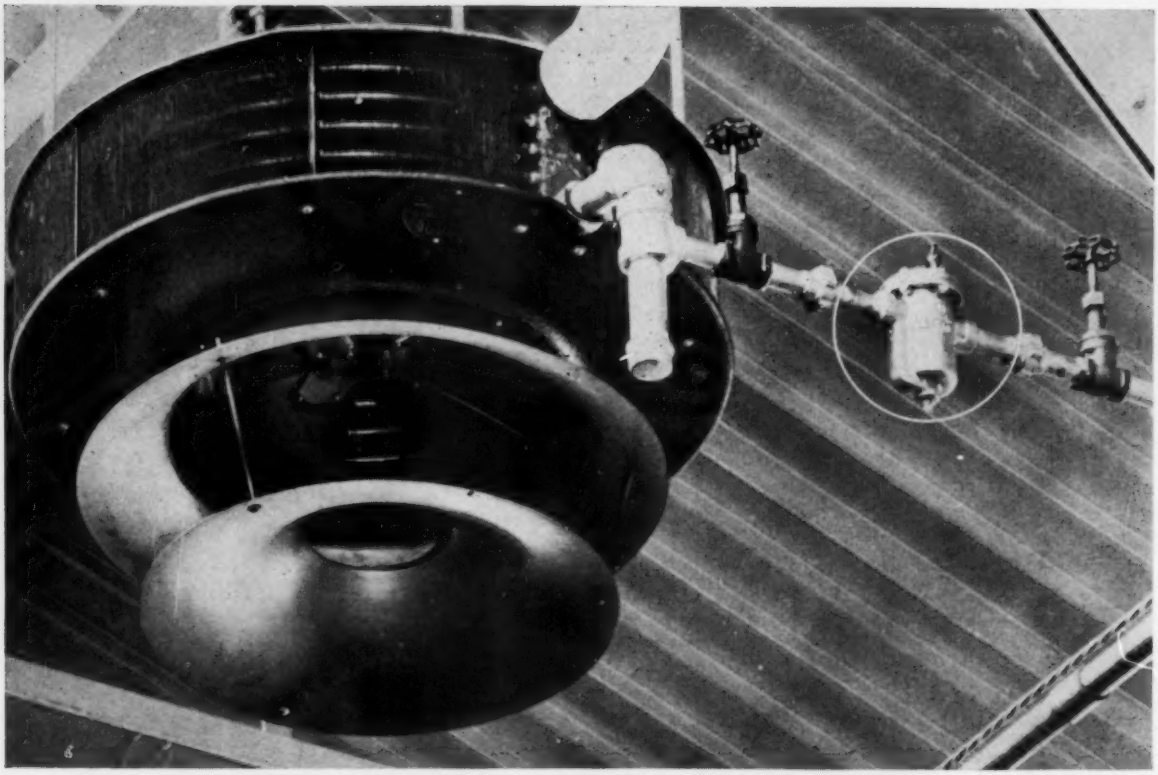


Here's the Way to Trap a Unit Heater for Lots of Heat and Little Maintenance

The picture above is an outstanding guide to good unit heater trapping. This installation provides maximum heater efficiency and minimum maintenance time and cost.

1. Simplified piping. Horizontal in-line piping is made possible by the Armstrong side inlet—side outlet trap body. Note that the trap can be opened by removing the cap, without disturbing pipe connections.

2. Dirt pocket ahead of trap. The vertical pipe leg collects heavy dirt and scale. No strainer is needed because the self-scrubbing action of an Armstrong trap washes ordinary dirt right through it.

3. Test valve. The maintenance engineer can check this trap quickly and easily by opening the test cock shown installed in the trap cap.

4. Shut-off valves and unions. The trap can be repaired, or replaced with a spare trap, without shutting off any other units.

5. Generous sized trap. The Armstrong trap, selected from Table B-29 or C-29 in The Armstrong Steam Trap Book, provides a minimum safety factor of 3 to 1 for this job. Its big air handling capacity keeps the heater free of corrosion-producing air and CO_2, provides fast heat-up and full rated btu output. No lag—condensate is discharged at steam temperature.

6. A good steam trap. The Armstrong trap discharges condensate at steam temperature and it has large air venting capacity. The heater is always full of hot, dry steam.

The Armstrong trap mechanism cannot clog, bind, stick or collapse. Valve and seat are hardened chrome steel—all other working parts are stainless.

An Armstrong trap is rated conservatively on a basis of actual hot condensate capacity under job operating conditions. This is not true of all traps and is an important factor when comparing prices.

Armstrong traps are sold by factory-trained Representatives under an unconditional, money-back guarantee of satisfaction to the user.

For the best in unit heater trapping, call your local Armstrong Representative, or write:

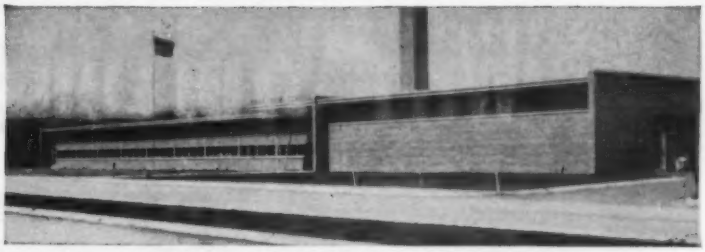
ARMSTRONG MACHINE WORKS
874 Maple Street • Three Rivers, Michigan

FREE — "How to Trap Unit Heaters" is the title of pages 28 and 29 in The Armstrong Steam Trap Book. This 44-page catalog is a guide to good trapping practice. Send for your copy.

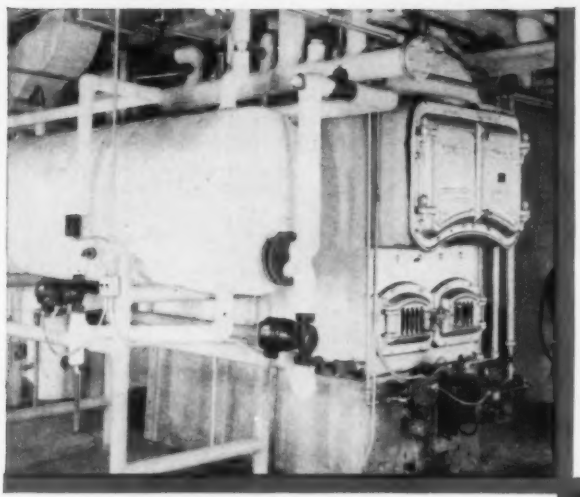
STEAM TRAPS FOR EVERY REQUIREMENT

ARMSTRONG
APPLICATION ENGINEERED
STEAM TRAPS

B&G *Hydro-Flo* System matches modern heating to modern design



PARK VIEW SCHOOL—MORTON GROVE, ILLINOIS
Consulting Engineer and Architect: Thomas J. Higgins Associates, Chicago, Illinois
Heating Contractor: E. J. Claffey, Chicago, Illinois
Plumbing Contractor: Fred Dietz, Chicago, Illinois



B&G Boosters are employed for pumping boiler water through a B&G Tank Heater and for recirculating hot service water through the system lines.

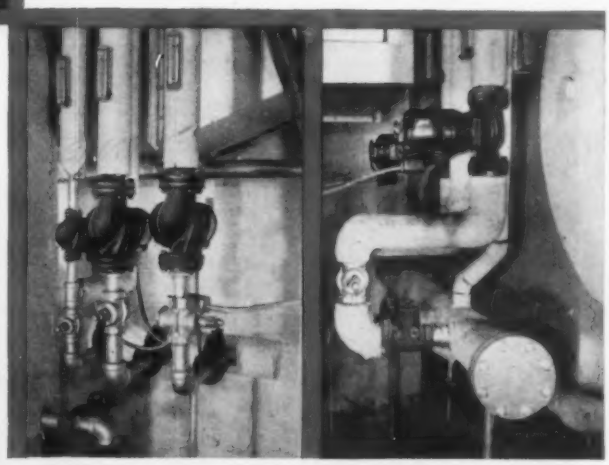
In this fine example of modern school design, the superior qualities of forced hot water as a heating medium are fully exhibited. Baseboard heating panels and radiant floor panels are used, to satisfy the comfort and health requirements of small children. For example, the radiant panels in the kindergarten permit children to take their daily naps upon throw rugs on the floor.

The close temperature control possible with B&G *Hydro-Flo* Heating . . . its economy of operation . . . its adaptability to zoning for varying temperature requirements, all account for the preference given it by designers and builders of today's schools.

For the most satisfactory solution to any heating problem, get the facts on B&G *Hydro-Flo* Heating. Send today for B&G Product Catalog.

"Water is the most efficient and economical medium for conveying a BTU"

*Reg. U.S. Pat. Off.

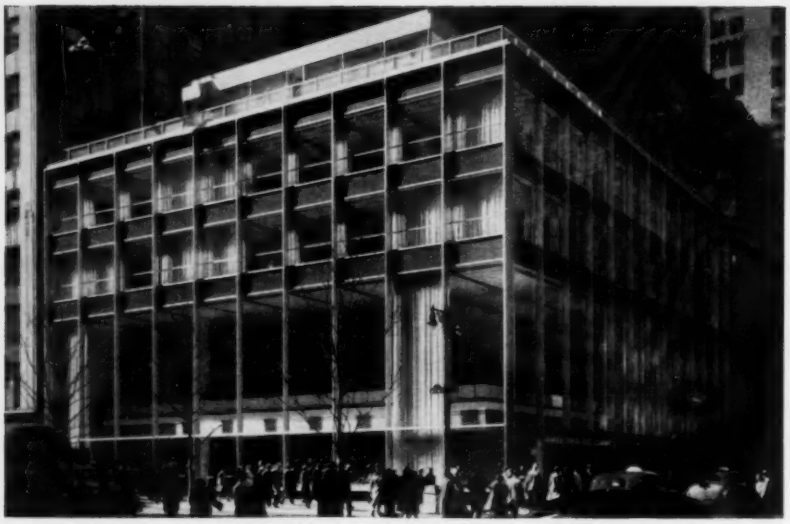


Two 2½" B&G Boosters supply hot water to baseboards in north and south classrooms. Radiant floor panels in the kindergarten are circulated by a 1¼" B&G Booster.

B&G Boosters circulate hot water to a unit heater in the lobby and to radiant floor panels in the lunch and all-purpose rooms.

BELL & GOSSETT COMPANY
Dept. DZ-5, Morton Grove, Illinois
Canadian License: S. A. Armstrong Ltd., 1400 O'Connor Drive, West Toronto

WHY Worthington rates so



UNUSUAL DESIGN

Completely sheathed in glass, the new Manufacturers Trust Building in New York posed an unusual air conditioning problem. The job is taken in stride by a modern Worthington central station system consisting of two 150-ton packaged water chillers.

HEAVY TRAFFIC

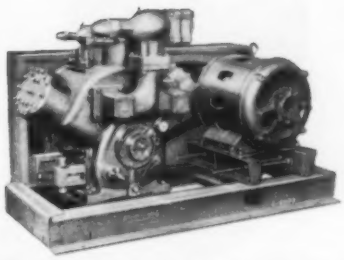
Keeping more than 12,000 people cool daily at New York City's new airlines terminal is a tough job. It's handled by a 315-ton Worthington centrifugal refrigeration system, together with Worthington air handling equipment and pumps.

HUMID HEAT

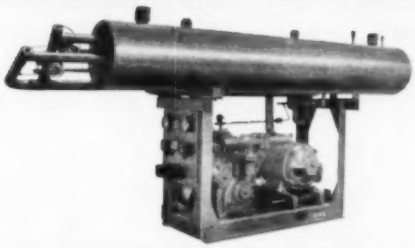
The Sterling, Miami Beach's newest oceanfront hotel, has *everything* but humid heat! An all-Worthington air conditioning system cools 142 rooms and 186,000 cubic feet of dining room and lobby space. Basic unit is a 60-ton Worthington "million-dollar" Freon compressor. Worthington packaged units are also spotted at key points.

many key air conditioning jobs

There are good reasons why unusual design, traffic or climate conditions can't trip up a Worthington dealer. He handles the most complete line of central station equipment in the industry. And, he's backed by Worthington's 70 years of specialized air conditioning experience. With assets like these, he's ready to take on *any* air conditioning job! For more details about the complete line, write Worthington Corporation, Air Conditioning and Refrigeration Division, Sect. A.5.57-HP, Harrison, New Jersey.

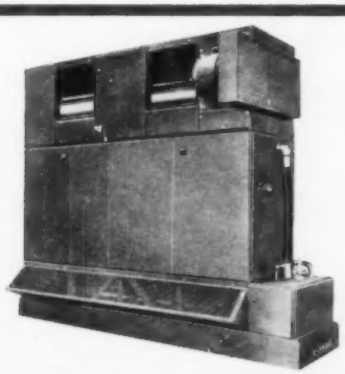


NEW FREON COMPRESSOR. Marked by sturdy construction and higher operating speeds, the new Freon compressor line ranges from 3-150 hp. Scientific balancing of rotating and reciprocating elements assures quiet, vibration-free operation.



COMPACT LIQUID CHILLERS, in sizes up to 200 hp, provide dependable air conditioning where chilled water is used as the cooling medium. Factory assembled units show trim design; require minimum floor space. "Hearts" of these units are Worthington Freon Compressors.

INDUCTION CIRCULATOR. Room air conditioning unit operating on high-pressure air induction principle. Used for perimeter cooling and heating of multi-story buildings. Absence of moving parts means long life, quiet operation. 75 to 1000 CFM total air distribution.



EVAPORATIVE UNITS are designed for application where water is high in cost or temperature. Units reduce water consumption by 90% or more; do not require cooling towers. Can be adapted for indoor or outdoor use. Six sizes range from 10 to 150 tons.

AIR HANDLING UNITS for remote air conditioning. Cooling coils available for direct expansion Freon-12, Freon-22, or chilled water. Floor and ceiling mounted units are functionally designed for easy installation and operation. 1,400 to 13,500 CFM.

A.5.57

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"Fastening collars on straight boots is real severe. No sheet has ever been able to take it—but SOFTITE did it!"

"At last a sheet that can take a Pittsburgh Lock without chipping or flaking—and SOFTITE did it!"

"We've never had a sheet that combined a ductile base with a real tight zinc coating—but SOFTITE did it!"

...they all said it couldn't be done–but

WHEELING SOFTITE®

galvanized sheets did it!

Ever since Wheeling SOFTITE Cop-R-Loy Galvanized Sheets were first introduced, metal workers have been torturing the sheet with every known test and operation. And the results are consistently the same – no flaking or peeling of coating.

That's because SOFTITE combines a soft, ductile base metal with the tightest zinc coating yet produced. So tight, in fact, that the coating will take anything that the base metal will!

Put SOFTITE to any test. See for yourself why the demand for SOFTITE has forced Wheeling to triple its production facilities in 1955. Try SOFTITE once and you'll see why actual users call Wheeling SOFTITE the best galvanized sheet yet produced.

For details call the nearest Wheeling warehouse or office.

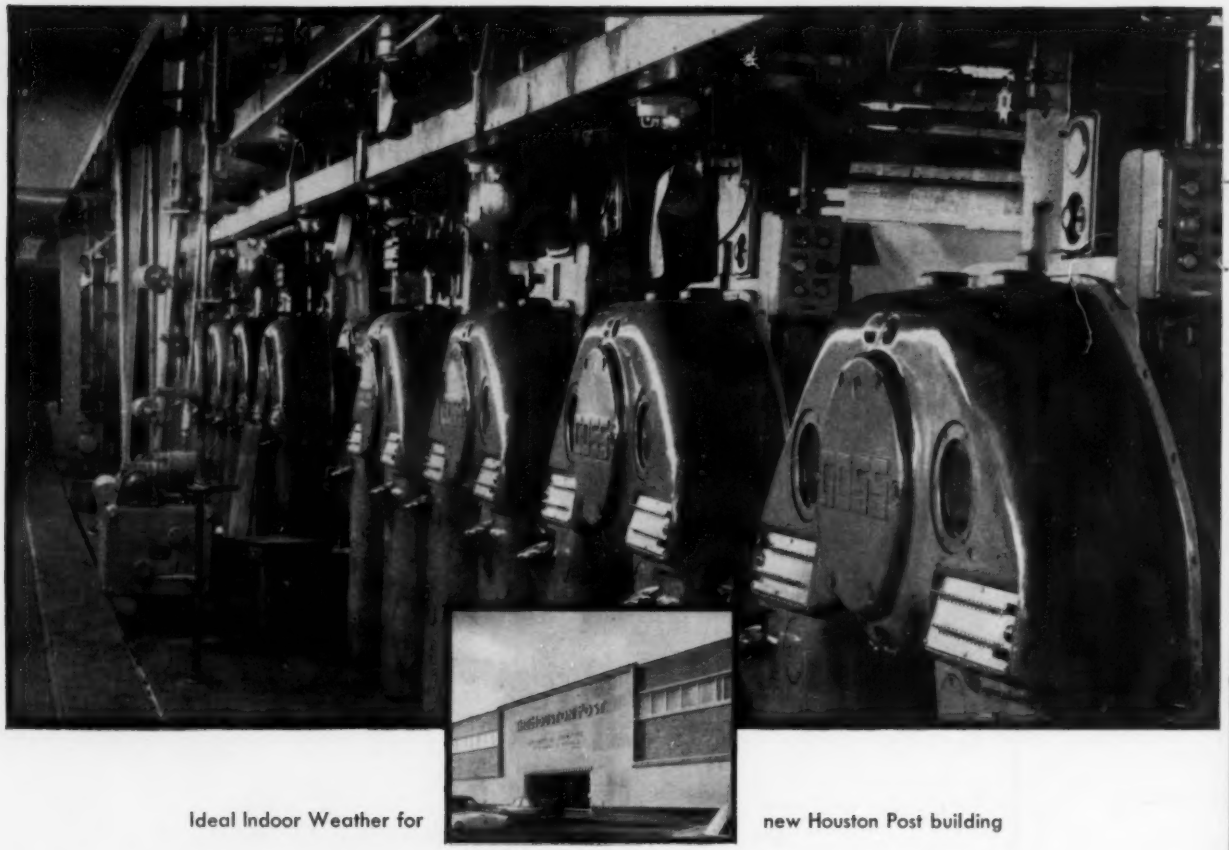
Wheeling also manufactures a complete line of Galvanized Furnace Pipe, snap lock or closed seam Perimeter Heating or Air Conditioning Pipe, and accessories.

Wheeling

WHEELING CORRUGATING COMPANY, WHEELING, WEST VIRGINIA

For your convenience, warehouse stock immediately available at these locations: Boston, Buffalo, Chicago, Columbus, Detroit, Kansas City, Louisville, Minneapolis, New Orleans, New York, Philadelphia, Richmond, St. Louis. Sales Offices: Atlanta, Houston.

Galvanized steel does it better... SOFTITE does it best!



Ideal Indoor Weather for new Houston Post building

Honeywell Electronic Control Panel operates 400-ton cooling plant automatically

New Honeywell control panel measures water temperature and flow, then selects proper cooling unit

A NEW method of regulating indoor weather is in use in the Houston (Texas) *Post's* modern publishing plant. It features a special control panel that governs the plant's 400-ton cooling system.

This special panel, a Honeywell Color-Graphic, automatically stops and starts the building's 150 and 250-ton centrifugal compressors. And it automatically operates the 150-ton, 250-ton unit, or both — depending on cooling needs. This assures the greatest economy of operation. Picture captions explain its functions in detail.

Throughout the building, from press room to executive offices, comfort levels are maintained summer and winter by strategically placed electronic thermostats. They're readily adjustable on the spot to meet the rapidly shifting comfort needs of a daily newspaper's large staff.

Automatic changeover from heating to cooling helps achieve both efficiency and economy.

These features and others described here demonstrate how electronics can bring modern atmosphere control to any building: you easily gain ideal indoor comfort through ideal control of temperatures and air circulation.

The techniques used to solve comfort problems of the Houston *Post* can help you provide better working weather for your clients. For a Honeywell Electronic Customized Temperature Control installation is designed to fit the needs of the building and its occupants.

For comfortable, more productive temperatures in new or existing buildings—of any size—specify Honeywell Electronic Customized Temperature Control

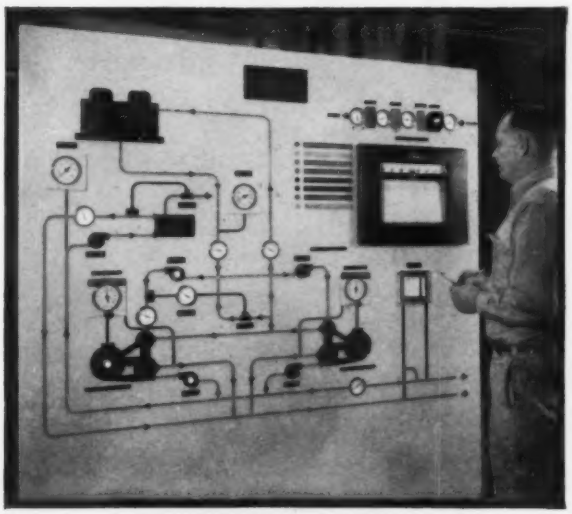
Whether it's a plant, bank, office, church, school, motel, hospital—any building of any size, new or existing—flexible Honeywell Electronic Customized Temperature Control can help meet your clients' heating, ventilating, air conditioning and industrial control requirements.

For all the facts on Honeywell Electronic Customized Temperature Control, and the economical Honeywell Periodic Maintenance Plan, call your Honeywell office. Or write Honeywell, Dept. HA-8-124, Minneapolis 8, Minn.

Air conditioned pressroom is an unusual feature of the Houston *Post* building. Despite heat generated by the huge presses, Honeywell controls maintain comfortable working temperatures, can be adjusted on the spot to meet varying comfort needs.

Herbert Voelcker & Associates, architects. Charles V. Chenault, consulting engineer. E. Lee Bond General Contractor. Wood-Leppard Air Conditioning Company, mechanical contractors.

Large open areas, like the Houston *Post* composing room, are held at maximum comfort throughout. Inexpensive, simply constructed electronic thermostats are placed at strategic locations in the building.



Key feature of the Houston *Post's* comfort system is the Honeywell Color-Graphic electronic control panel. Carefully customized to the building's special needs, the panel operates two centrifugal compressors, two chilled water pumps and two condenser water pumps. With electronic accuracy, it *automatically* guides these units through the operational cycle, going from minimum to maximum cooling capacity of 400 tons. The panel also determines cooling load requirements by an ingenious method; measuring temperature differential of supply and return water, and gallons per minute being delivered to the system. Completely automatic operation frees a full time engineer for other duties. Normally a cooling plant of this size requires his full attention.

Advantages of an Electronic Control System

An Electronic control system is the most *flexible* control system you can use. It lets you:

operate your thermostats *as* you want to

sequence from your thermostats *when* you want to

locate your thermostats *where* you want to

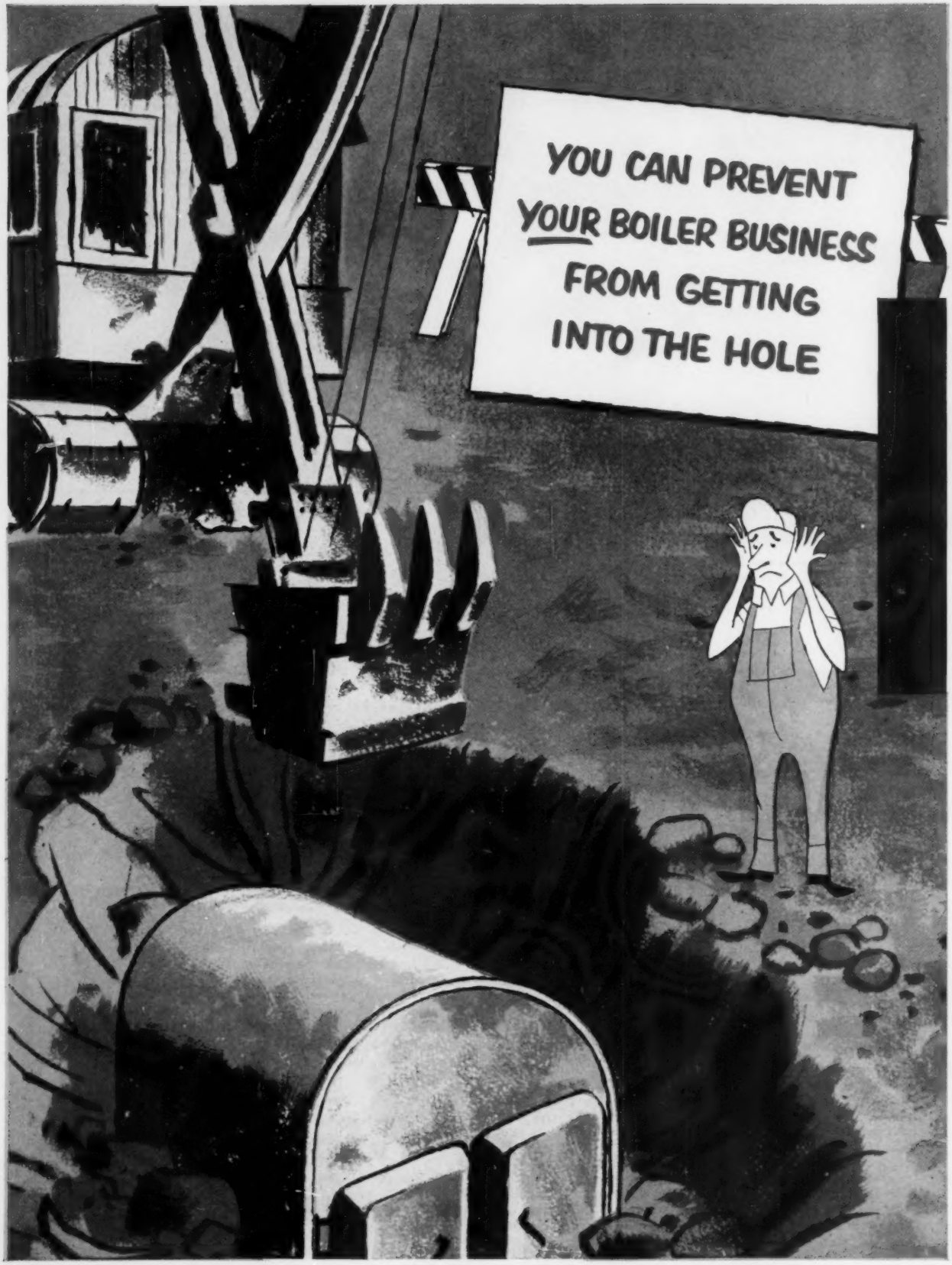
compensate your thermostats *as much as* you want to

W. Howard Baldwin, Houston *Post* vice-president and general manager, says: "Our new four-million-dollar plant was built with an eye to the future. Electronic temperature control, plus control centralization with a Color-Graphic panel by Honeywell, were selected to ensure a modern control system for the many years to come."

MINNEAPOLIS
Honeywell

Electronic Controls

112 offices across the nation


YOU CAN PREVENT
YOUR BOILER BUSINESS
FROM GETTING
INTO THE HOLE

Here's a real product advantage that will enable you to land more installations on new construction than ever before. Show the builder that he can save the cost of digging the pit required for conventional commercial boilers . . .

install the unique

SPENCER "LW"

Lower waterline—over-all height of the Spencer "LW" is approximately 25% less than conventional firebox boilers . . . saves excavation costs in new buildings by eliminating pit usually required.

Built in two sections—in existing buildings, divided design permits entry through narrow basement openings without tearing out walls. The two watertight sections are moved in separately with no welding for installation.

Let Spencer build up your boiler business—write Dept. HP-85

New Spencer "C." Heavy-duty commercial boiler performance at a residential boiler price! Can be fired with oil, gas or coal.

Spencer "A." Complete range of sizes from 3,500 to 50,000 sq. ft. steam, net SBI ratings. For *every* building . . . for *every* fuel.

SPENCER
HEATER
LYCOMING DIVISION
WILLIAMSPORT AVCO PENNSYLVANIA

ASME and SBI Approved SBI

LESS THAN 2 TEASPOONS

genetron 141—GREEN LABEL
MONOCHLORODIFLUOROMETHANE

Quality Specifications

Moisture wt. %, max.	0.0010
Chlorides	none
High boiling impurities—vol. %, max.	0.05
Non-condensable gases (gases insoluble in perchloroethylene)—vol. % in vapor phase, max.	1.5
Boiling pt. at 760 mm. Hg. °F	−41.4
Boiling range °F (to 85% pt.), max.	0.9

genetron 12—WHITE LABEL
DICHLORODIFLUOROMETHANE

Quality Specifications

Moisture wt. %, max.	0.0010
Chlorides	none
High boiling impurities—vol. %, max.	0.05
Non-condensable gases (gases insoluble in perchloroethylene)—vol. % in vapor phase, max.	1.5
Boiling pt. at 760 mm. Hg. °F max.	−21.4
Boiling range °F (to 85% pt.), max.	0.9

genetron 11—ORANGE LABEL
TRICHLOROMONOFLUOROMETHANE

Quality Specifications

Moisture wt. %, max.	0.0015
Chlorides	none
High boiling impurities—vol. %, max.	0.05
Boiling point at 760 mm. Hg. °F	74.7
Boiling range °F (to 85% pt.), max.	0.5

OF WATER IN ONE TON!

genetron®

Super-Dry Refrigerants

Two teaspoons of water aren't enough to cool your breakfast coffee or wet your whistle on a hot day . . . yet, that's the maximum amount of moisture ever found in a 2,000-lb. cylinder of "Genetron" Super-Dry Refrigerants. And, the amount in a single 145-lb. cylinder wouldn't even fog a man's glasses!

Actually, it takes the most delicate and accurate scientific apparatus to measure moisture in "Genetrons," for the content is so infinitely small that it must be expressed in parts per million.

For example, "Genetron" 12—White Label—and "Genetron" 141—Green Label—are so dry they contain less than 10 parts of water per million parts of refrigerant. That's moisture equal to only one/thousandth of one per cent (0.001%).

And, the overall purity of "Genetron" Super-Dry Refrigerants is equally good, for they are manufactured to meet quality standards which are in many respects more rigid than those for the purest research chemicals.

Look at the stringent manufacturing specifications listed here. See how low "Genetrons" also are in non-condensable gases and low boiling impurities. And, remember that the quality of current production consistently surpasses even these specifications.

It's easy to see why so many leading manufacturers have now chosen "Genetron" Super-Dry Refrigerants as the original charge for their equipment. Their tests have proved "Genetrons" meet every requirement for reliable refrigerants.

So—be sure—always use "Genetron" Super-Dry Refrigerants—made by General Chemical, America's foremost producer of high purity laboratory and scientific chemicals.

Basic Chemicals for American Industry

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago Cleveland • Denver • Detroit • Greenville (Miss.) • Houston • Jacksonville • Kalamazoo • Los Angeles Minneapolis • New York • Philadelphia • Pittsburgh • Providence • San Francisco • Seattle • St. Louis Yakima (Wash.) • In Wisconsin: General Chemical Company, Inc., Milwaukee

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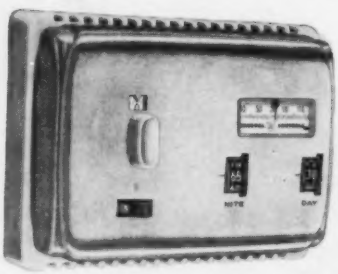
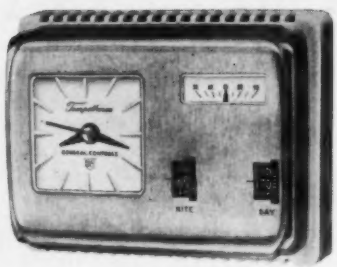
BEST 15 YEARS AGO.....STILL BEST TODAY!

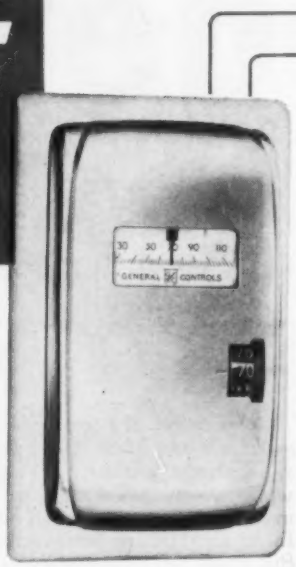
...Feature General Controls self-powered



T-265 Timer Thermostat—automatically switches from night level to day level after expiration of selected interval which is manually set by spring-type timer.



T-270 Tempetherm—combination clock thermostat switches from day to night temperatures absolutely automatically. Set it—like a clock—and forget it!



T-99 Thermostat—mercury switch design, hermetically sealed contacts. **T-80 Thermostat**—thermopoised contacts, especially sensitive for "straight line" temperature control.

WHY SELF-POWERED CONTROLS ARE GOOD:

1. **Customers appreciate low cost installation**—and the savings made possible by its design simplicity—two parts, no special wiring, no special mounting.
2. **Customers are completely satisfied with quiet operation**—and you are saved the time-consuming service calls and "headaches" of noise complaints.
3. **Customers have no power-failure problems**—whatever the weather does to regular power lines, this self-contained system goes right on delivering uninterrupted comfort.
4. **Customers save on service calls**—B-60 valve automatically recycles after minimum pilot condition has been corrected. Main line shutoff if pilot should go out.

WHY GENERAL CONTROLS' B-60 SYSTEM IS BETTER!

1. **You know it's best by actual test**—that is guaranteed by 15 years of field performance covering hundreds of thousands of service-free installations.
2. **Your installation problems are gone**—the simplified wiring block is on *top* of the valve. Terminals are always easy to get at. No special wiring or mounting.
3. **You can count on top performance all the time**—with the powerful 700 millivolt generator and stable blue-flame pilot for reliable operation in the roughest installations.
4. **You have no "Lint-plug" worries**—General Controls "Snorkel" design completely eliminates lint interference, makes those difficult "above the floor" jobs truly worry-free.

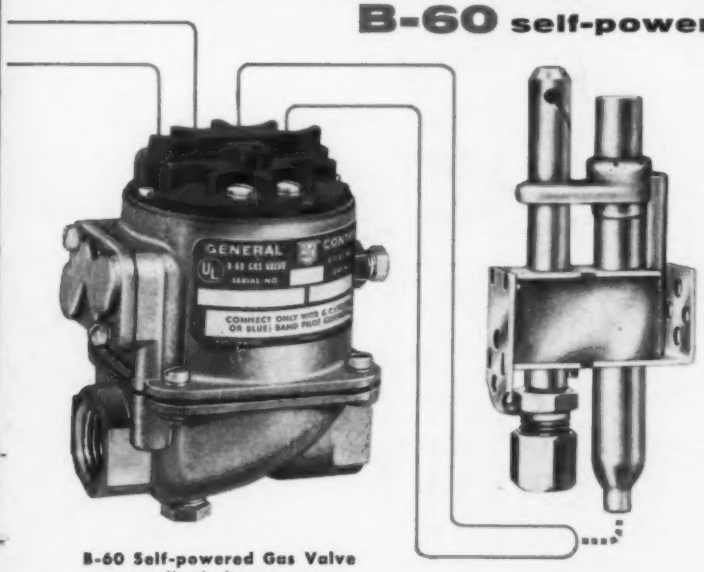
by feature, point by point...

famous B-60 is the best

gas control system money can buy!

The original...first and still foremost...

B-60 self-powered gas control system



B-60 Self-powered Gas Valve operates silently from power supplied by pilot; provides gas in response to thermostat and automatically shuts off for safety if pilot goes out. Space-saving, multipoised models available.

PG-9 "Snorkel" Pilot Generator—does triple duty: eliminates lint problems, provides blue-flame ignition, and generates 700 millivolt power to operate entire control system.

No outside current required! No power-failure service calls! Quiet operation with accurate temperature control and positive safety! These are the performance features which electrified the heating industry with the introduction of the revolutionary B-60 Control System 15 years ago. And today—proved by hundreds of thousands of trouble-free applications ...the famous General Controls B-60 system with its 700 millivolt pilot generator still fits by far the greatest range of applications—still stands *first and foremost* in the heat control field!

General Controls

self-powered

B-60

System

1938 20 YEARS 1955

1955 SIXTEENTH JUBILEE YEAR G C

General Controls outstanding B-60 control system is custom-matched to the famous line of General Controls room thermostats... distinguished alike for their style and performance...available in mercury, snap-action, and thermopoised designs for accurate, straight-line temperature control. Your best guarantee of customer satisfaction.

GENERAL CONTROLS

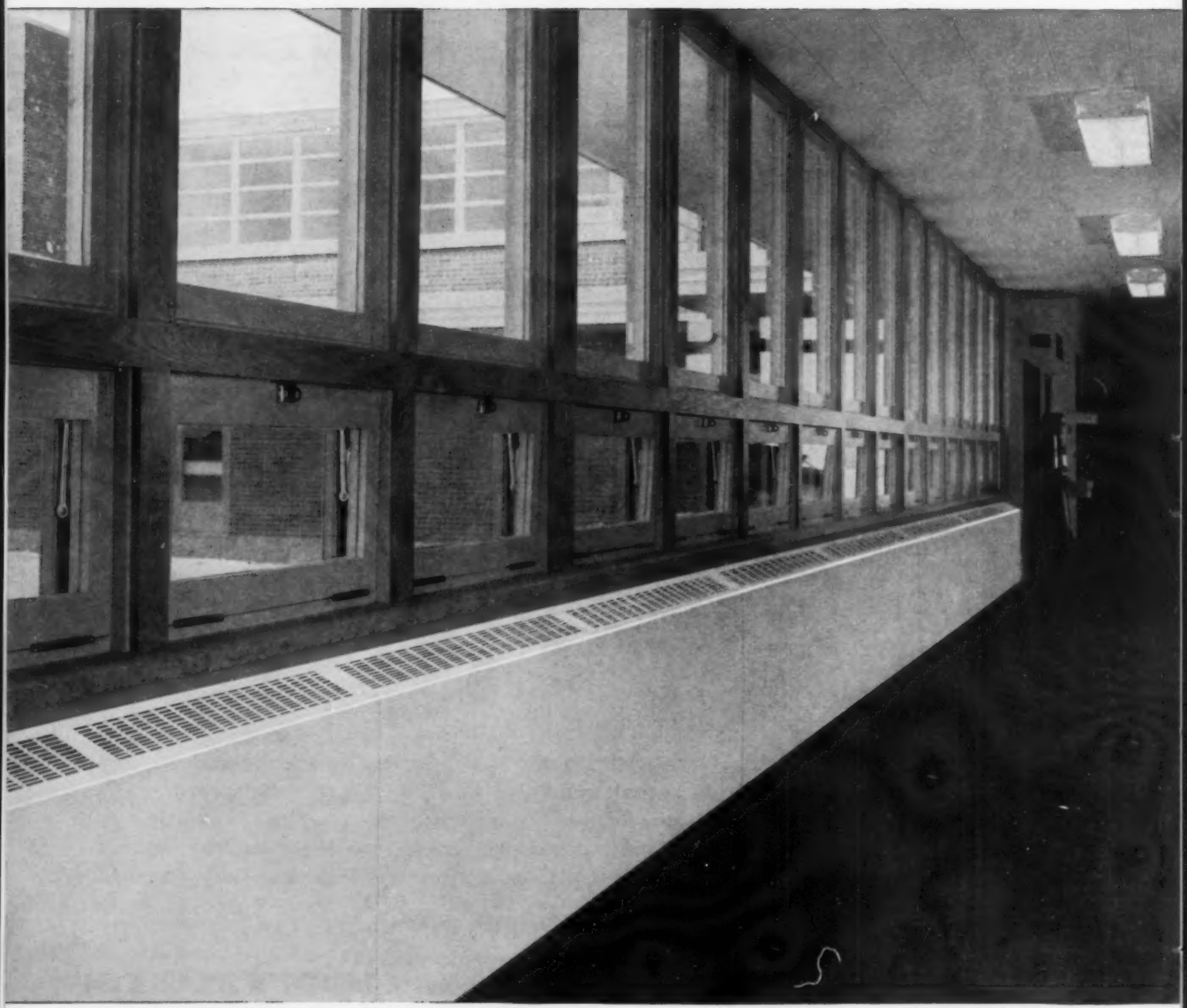
MANUFACTURERS OF AUTOMATIC CONTROLS FOR HOME, INDUSTRY AND THE MILITARY

GENERAL CONTROLS • PERFEX CONTROLS

40 FACTORY BRANCH OFFICES SERVING THE UNITED STATES AND CANADA

FIVE PLANTS: IRON MOUNTAIN, MICHIGAN • GLENDALE, CALIFORNIA • BURBANK, CALIFORNIA • SKOKIE, ILLINOIS • GUELPH, CANADA

. . . Say "Trane"—and



Trane Wall Line Convectors combine *low initial cost* with *low installation cost* to meet even the tightest heating budgets. Designed for attractive wall-to-wall applications in schools, office buildings, hospitals and institutions . . . wherever *high capacity* and *economy* are a must. Unusually rugged construction with extra reinforcements and full back. Over-all cabinet heights 14″, 20″, 26″; depths 4″ and 6″; lengths to 72″.

fill any radiation need!

Nation's most complete line of fin-type radiation simplifies specifications and maintenance... concentrates responsibility.

CHURCH ROOM OR CLASSROOM, hospital, home or factory—no matter what type of building or where—*no matter what type of radiation*—this one-source supply can cut design time and help you plan better.

Specifications are simplified, maintenance made easier. And the reason is simple. TRANE manufactures the nation's most complete line of fin-type radiation, so *you* can concentrate responsibility in *one* reliable source.

Since 1925 TRANE has led the way in developing and improving a broad line of radiation products. You can depend on TRANE quality and TRANE ratings in job after job after job. TRANE product literature is complete, easy to use.

So on your next job—say "TRANE." Call your nearby TRANE Sales Office, or write TRANE, La Crosse, Wisconsin.

TRANE

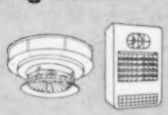
MANUFACTURING ENGINEERS

One source, one responsibility for:
Air Conditioning • Heating • Ventilating
Heat Transfer Equipment

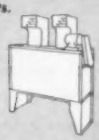
The Trane Company, La Crosse, Wis. • Eastern Mfg. Div., Scranton, Pa. • Trane Co. of Canada, Ltd., Toronto • 90 U.S. and 17 Canadian Offices

Matched Trane products for *all* your heating needs

Force-Flo heaters block cold air, stop drafts.



Model H & P unit heaters put heat where you want it.



Tofridor heaters deliver large volumes of air long distances.

Steam Specialties include full line of valves, traps, vents.

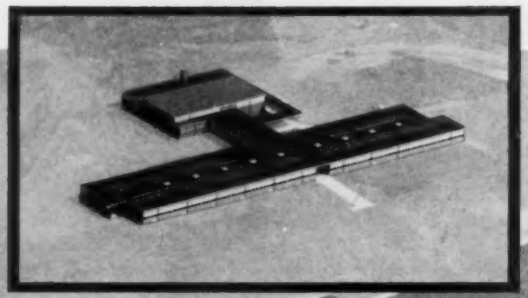
Trane Wall-Fin brings draft-free heating to long wall and window areas. Large tube diameters make it especially suitable for loop systems where pressure drop is critical. Use single element where capacity requirements are low, multi-tiered elements where high capacity per lineal foot is required. Sloping-top cabinets or expanded metal grilles. Choice of 1¼" or 2" steel or 1" or 1¼" nominal copper elements.

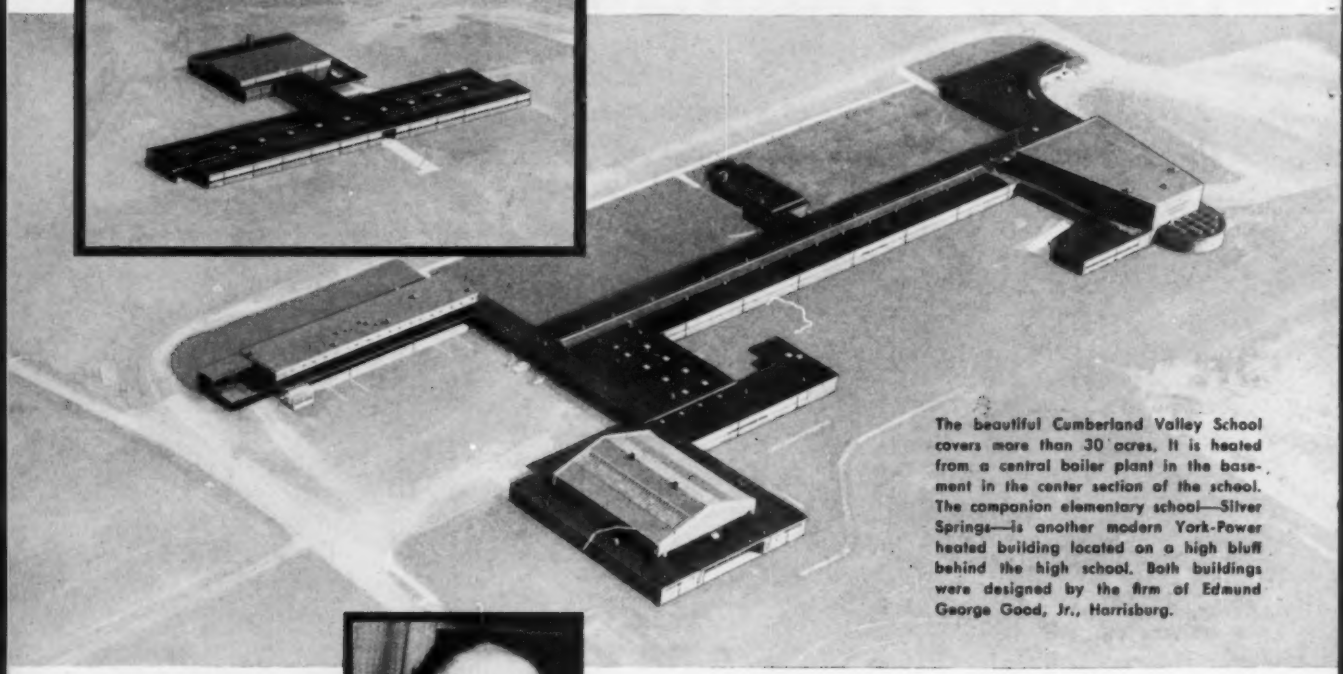
Trane Convectors combine efficiency with compactness and beauty. Aluminum-copper heating element responds quickly, provides heat instantly . . . eliminates wasteful overheating common to other types of radiation. Ideal for homes, offices, institutions. Can be installed free-standing, recessed or wall-hung. 21 cabinet styles with flat or sloping tops. Knob or chain dampers optional.

Trane Baseboard Convectors assure your homeowner clients greater comfort by heating where the cold begins —along *outer* walls, *under* windows. Give greater freedom of furniture arrangement, add beauty to any home. And they may be installed up to 50% faster because cabinet and coil come preassembled, closures *snap* together. Nonferrous heating element. 8¼" and 12" heights.

YORK-POWER

...AND IMPROVE OPERATING





The beautiful Cumberland Valley School covers more than 30 acres. It is heated from a central boiler plant in the basement in the center section of the school. The companion elementary school—Silver Springs—is another modern York-Power heated building located on a high bluff behind the high school. Both buildings were designed by the firm of Edmund George Good, Jr., Harrisburg.

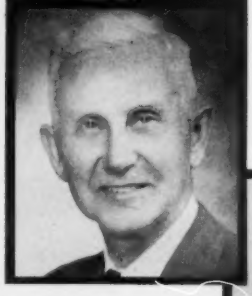
IN BOILER ROOM DESIGN

Edmund George Good, Jr., registered architect, Harrisburg, Penna., found that the York-Power Factory-Coordinated fuel burning systems offered the modern unitary design features that he desired in planning the boiler rooms for the prize-winning Cumberland Valley School jointure west of Harrisburg. "This equipment gave us the necessary controls and safety features which are so important," Mr. Good stated.

IN BOILER ROOM ENGINEERING

Charles Johnson, P. E., consulting engineer of Lemoyne Penna., heating and air-conditioning specialist, reports the "York-Power's F/C panel board with its packaged control system, with all controls factory wired for easy connection in the field, simplified installation and eliminated ragged field wiring."

IN EQUIPMENT INSTALLATION



"The York-Power F/C system with its windboxes and refractory rings for quick installation of York-Power burners to the boiler eliminated costly boiler checkerwork in the installation and the factory-wired F/C panel board enabled us to make fast, economical installation of the oil-fired system," R. E. Wolfe, Harrisburg heating contractor for Cumberland Valley School, stated.

"Our confidence in York-Power burners, built up through years of experience with the equipment, was fully justified in the installation at the Silver Springs School," Walter C. Eshenaur, Penbrook (Harrisburg) heating contractor, reported. "The start up was good and the automatic operation with modulation was trouble-free during the first heating season."

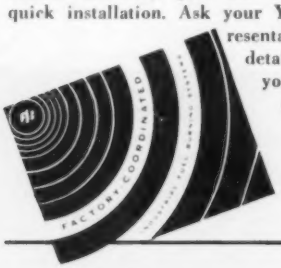
F/C SYSTEMS HELP COST SAVINGS

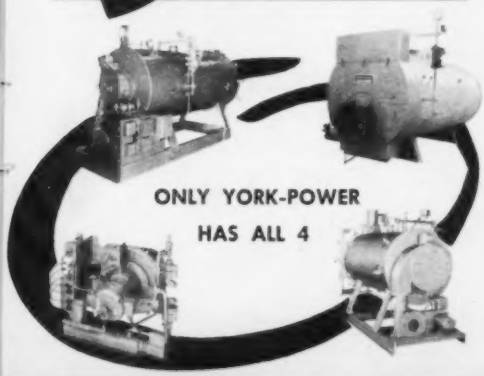
CONDITIONS IN MODERN SCHOOLS

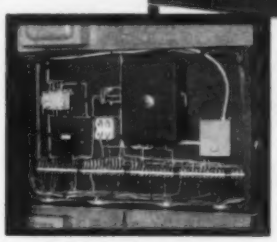
F/C Panel Boards, part of the complete York-Power factory coordinated industrial fuel burning system, protect all controls from damage, dirt, and dust because they are housed in air-tight steel cabinets. F/C Panels are unitary in design so that all auxiliary units can be installed adjacent to them to provide an eye-appealing set up. Controls within the panels are wired at the factory to terminal strips for fast, trouble-free field wiring. These completely factory-coordinated fuel burning systems provide the modern answer to economical, low-cost installations.

Larry Witmer, engineer in charge of the Cumberland Valley School installation says "The York-Power F/C System makes my job of power plant operation and supervision much easier because all of the controls are easy to service, and are kept clean in their dust-free steel cabinets."

The heart of the York-Power F/C System is the time-tested, field-proven York-Power Horizontal Rotary Oil Burner. These precision fuel-burning units provide complete modulation over the entire firing cycle. They are designed for operation with light or heavy oil, and/or gas, and have all of the advanced engineering features necessary for precision combustion. York-Power F/C windbox assemblies provide the precise air control necessary, plus the added feature of quick installation. Ask your York-Power representative for further details, or write on your letterhead for a free copy of 12-page F/C booklet.

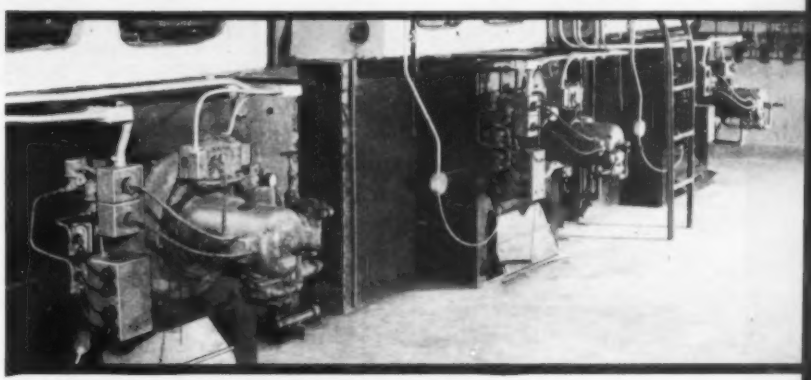






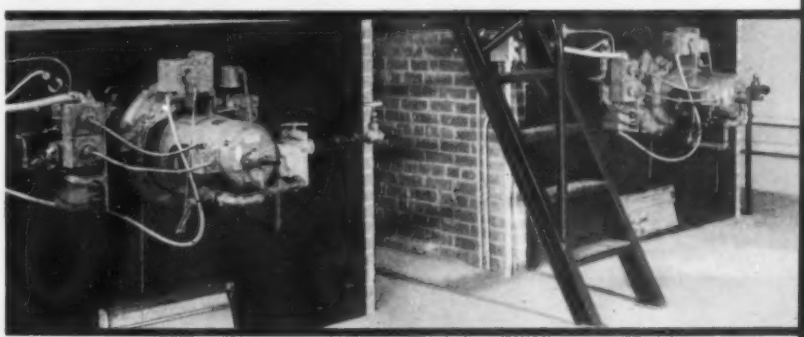
F/C PANEL BOARDS

These York-Power F/C Panel Boards provide the control for three burners in the high school. Main panel boards (Model F/C 1001) include the controls for FP-2 System. Subsidiary panels handle: Draft Inducer; Master Relay Controls. ● Details of wiring of a main panel are shown in inset photograph.



F/C FUEL BURNING SYSTEMS

The Cumberland Valley School installation includes three C-175-AGM (15 to 60 G.P.H.) York-Power Industrial Burners attached to the boilers with York-Power windbox assemblies. Two No. 400 Pump Sets handle the fuel oil. ● Two B1-100-AGM Burners (11 to 33 G.P.H.) fire the boilers for Silver Springs Elementary School. Two No. 225 Pump Sets are used. These burners are shown in the photograph at the bottom of the page.



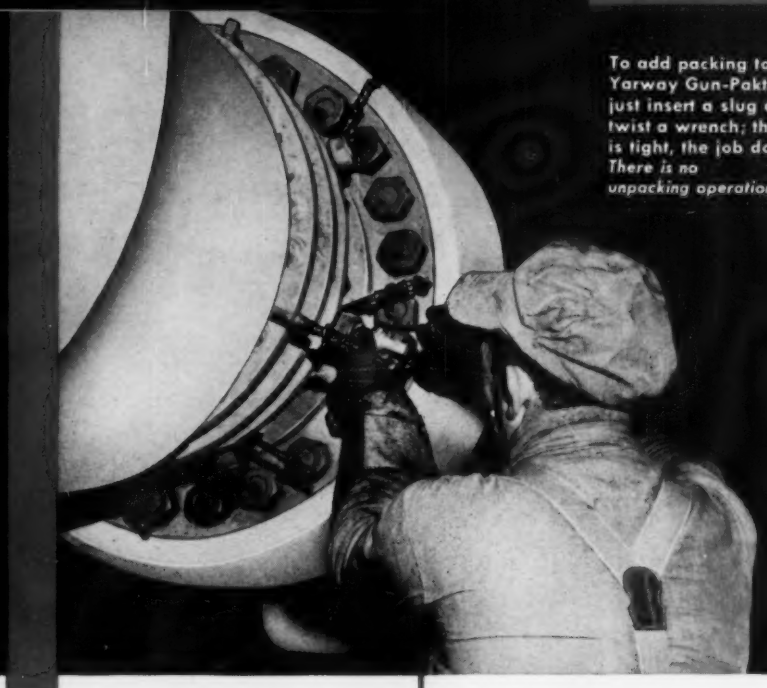
YORK-SHIPLEY, INC.

YORK, PENNSYLVANIA

INDUSTRIAL POWER AND HEATING SPECIALISTS SINCE 1918

STARTLING NEW FACTS ON EXPANSION JOINT MAINTENANCE

It may cost less than you think to service expansion joints. Look at these records from three typical users of Yarway Gun-Pakt Expansion Joints:



To add packing to a Yarway Gun-Pakt joint, just insert a slug and twist a wrench; the joint is tight, the job done. *There is no unpacking operation.*

	YARWAY GUN-PAKT JOINTS	CONVENTIONAL GLAND-PACKED JOINTS
STATE UNIVERSITY*	Required addition of only 3 slugs (45 cents) of packing in 5 years. Lubrication only once every 6 months. Total labor time of only 2 manhours in 5 years.	Same lubrication as Gun-Pakt, *plus* gland tightening, *plus* complete overhaul with shutdown for unpacking and repacking every 3 to 4 years. Time for overhaul—25 manhours per joint!
MID-WEST AIRFIELD*	Only maintenance was lubrication and addition of 2 slugs (30 cents) of packing per year. Total labor ¼ manhour per joint per year.	Lubrication and gland tightening required 8 manhours per joint per year—plus complete unpacking and overhaul every 2 to 3 years. Time required for overhaul—20 manhours per joint.
"BIG TEN" UNIVERSITY*	Lubrication only once every 2 months, with packing added as needed. Total labor time charged, 1 manhour per joint per year.	General maintenance requires 6 manhours per joint per year. Complete overhaul required every 2 to 3 years with unpacking and repacking—24 manhours per joint.

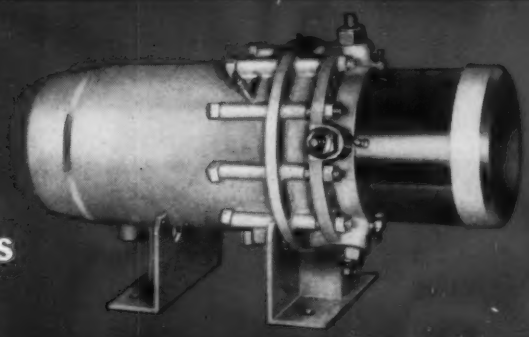
*Names on request.

To get the full facts on Yarway Gun-Pakt Expansion Joints, and how they can save you maintenance money, write for Yarway Bulletin EJ-1913.

YARNALL-WARING COMPANY
107 Mermaid Ave., Philadelphia 18, Pa.

YARWAY

Yarway single-end, welding type Gun-Pakt joint for pressures to 300 psi, heavier design for higher pressures. Single-end traverses up to 12 inches; double-end up to 24 inches.



gun-pakt expansion joints

New Sarco Thermodynamic Steam Trap practically eliminates maintenance!

Only moving part—a hardened Solid Stainless Steel Disc—practically wear-proof!

SOME OF MANY ADVANTAGES

1. Same trap for all loads and pressures 10-600 psi.

2. Closes tight on no load.

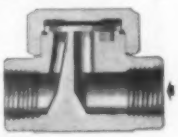
3. Operates against back pressures up to 50% of inlet pressure.

4. Not affected by superheat, water-hammer, vibration, corrosive condensate.

5. Smallest inventory of spare parts.

SIMPLICITY—to the Nth degree!

No valve-closing mechanisms to wear or stick. No critical clearances to choke. No gaskets to leak. Three simple parts...machined from stainless steel bar stock. Only one moving part.
What could be simpler?



SARCO COMPANY, INC.

2133-B

Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

Please send me: ☐ Bulletin 255-44
☐ A Sarco Thermodynamic Steam Trap for 60-day trial. Size_____ for installation on_____

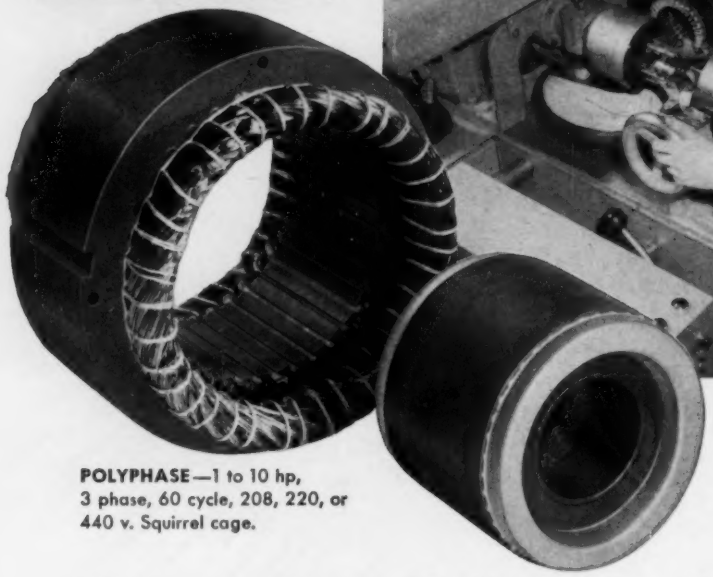
NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

Wagner®
ELECTRIC MOTORS
... the choice of leaders in industry



POLYPHASE—1 to 10 hp, 3 phase, 60 cycle, 208, 220, or 440 v. Squirrel cage.

This photograph shows one of the stator winding machines used on Wagner's hermetic motor production lines. These machines, especially designed by Wagner engineers, are part of Wagner's modern motor production facilities.

Wagner Hermetic Motors...built to give you better sealed-unit performance

SINGLE-PHASE
¼ to 5 hp, 60 cycle, 115 or 230 v. Split-Phase, Capacitor-start induction run, Capacitor-start and run.

When you design or build a refrigeration condensing unit that is to be hermetically sealed—*choose your motor drive with care.* Remember, it's your product that the user blames if the motor fails. But, if you use a Wagner motor, our reputation is at stake, too.

For that reason, we can't be satisfied to make just another hermetic motor . . . we can't be satisfied to merely meet industry standards.

That's why only the newest and best production tools available anywhere are used on Wagner's hermetic motor assembly lines.

That's why repetitive surge tests and dielectric tests are given to *every* Wagner hermetic motor stator. And that's why every rotor that goes into a Wagner hermetic motor is given an individual speed test. It's this exacting kind of quality control that contributes to the long service life of each Wagner hermetic motor.

When your motor drives are to be hermetically sealed, it's to your advantage to specify *Wagner* for use on your equipment. Get the facts . . . call the nearest of our 32 branch offices, or write us.

Wagner Electric Corporation
6370 Plymouth Ave., St. Louis 14, Mo., U.S.A.

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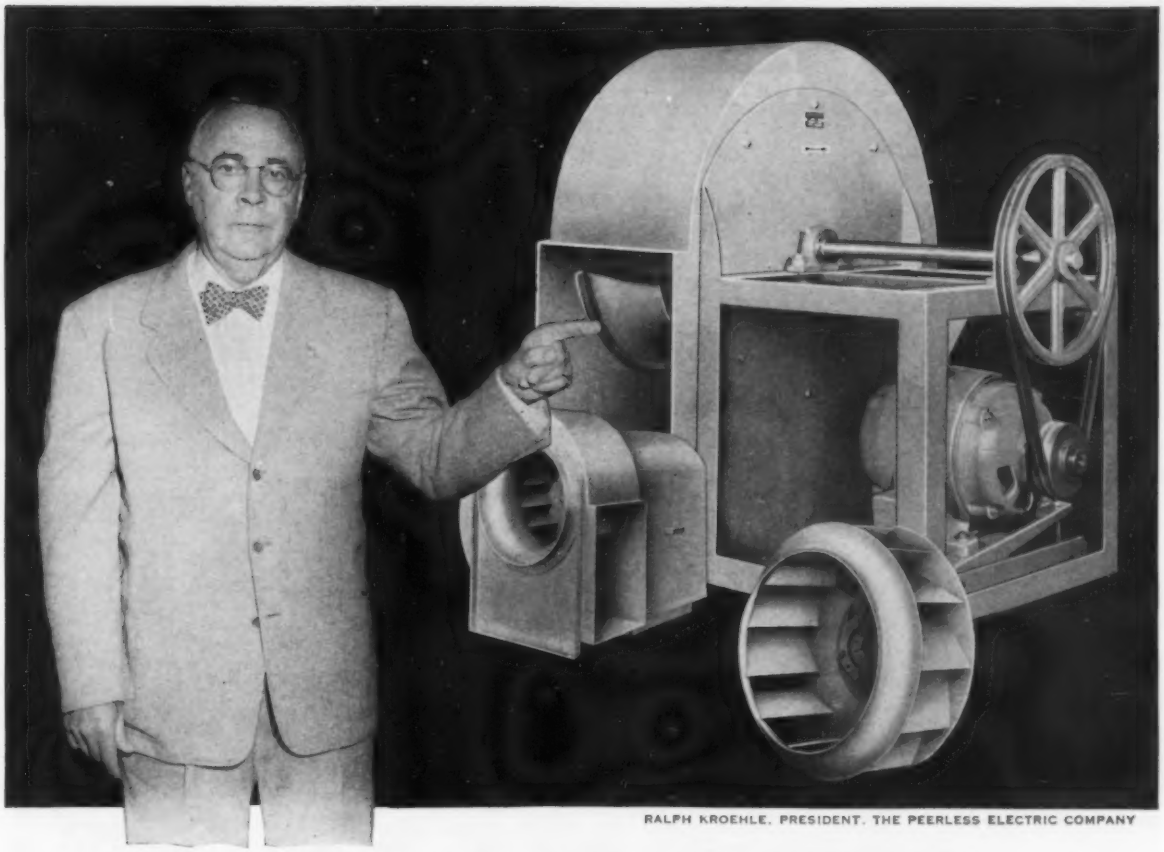
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC



RALPH KROEHLE, PRESIDENT, THE PEERLESS ELECTRIC COMPANY

"...THE BEST BLOWER ENGINEERING..."

● Peerless engineers work under orders to give every fan and blower "the best possible engineering." Our engineering standards now meet or exceed all industry codes. The reason is simple.

COMPLETE ENGINEERING—Peerless builds its own motors and job matches them to meet blower requirements. They have the advantage of being one complete unit, tested thoroughly for motor characteristics, speed and drive alignment.

HEAVY CONSTRUCTION—Peerless frames and housings are better and of heavier construction than any competitive products. Construction is all-welded. The result is a vibration-free unit.

NAFM APPROVED—Peerless Backward Curve Belt Drive Utility Blowers in sizes from 12½" to 36½" meet all NAFM recommendations. They have self-limiting horsepower characteristics and dynamically balanced wheels with matched spun cones. There is nothing in the air stream. Operation is exceptionally quiet.

CERTIFIED RATINGS
AUTHORIZED BY N A F M

PERFORMANCE DATA—Complete data on Peerless fans and blowers is cataloged for easy reference. Bulletin SDA-160 shows all fans and forward curve blowers. Bulletin SDA-200 gives all data on backward curve blowers (NAFM) from 12½" to 36½". Use the coupon below to get your file copy. Dimension prints are available on request.

THE PEERLESS ELECTRIC CO.
WARREN, OHIO

☐ Send me Bulletin SDA-160.
☐ Send me Bulletin SDA-200.

NAME .....
TITLE .....
COMPANY .....
ADDRESS .....

FAN AND BLOWER DIVISION
Peerless Electric
THE PEERLESS ELECTRIC COMPANY
1409 W. MARKET ST. • WARREN, OHIO
FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT

Stocked for fast service to you!

7 Points of uniform goodness in YOUNGSTOWN PIPE

uniform ductility
uniform lengths
uniform threading
uniform weldability
uniform wall thickness and size
uniform strength and toughness
uniform roundness and straightness

●Your nearby Youngstown Distributor carries a complete stock of good steel pipe, and he'll deliver your order quickly. That's an important help for you. It saves you time delays on jobs and the expense of carrying costly, excess inventory. For all your steel pipe needs, call your Youngstown Distributor.

Youngstown

QUALITY YOUNGSTOWN SERVICE

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

General Offices: Youngstown, Ohio - District Sales Offices in Principal Cities

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - BAR SHAPES - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - RAILROAD TRACK SPIKES

*Quality Control from molten metal ... to finished product

Pacific *Quality-Controlled* fittings are inspected and tested at every stage of production to assure *thread-perfect fittings that fit.*

From physical tests of sand and core—through numerous tests during the melting, pouring, molding and annealing operations—to precision threading and final physical inspection, fittings must pass more than 10 major inspections with a 100% rating before being accepted by Pacific's *QC Department.

Pacific's line through 2″ pipe sizes is available "Package-Protected" for cleaner handling, easier storage and quicker inventory. 2½″ and larger sizes are available in bulk.

Malleable Iron Unions
Ground Joint, Brass Seat

Steel
Pipe Couplings

Steel • Iron • Brass
Pipe Nipples

pipe fittings are not all alike For Quality and Reliability — Specify

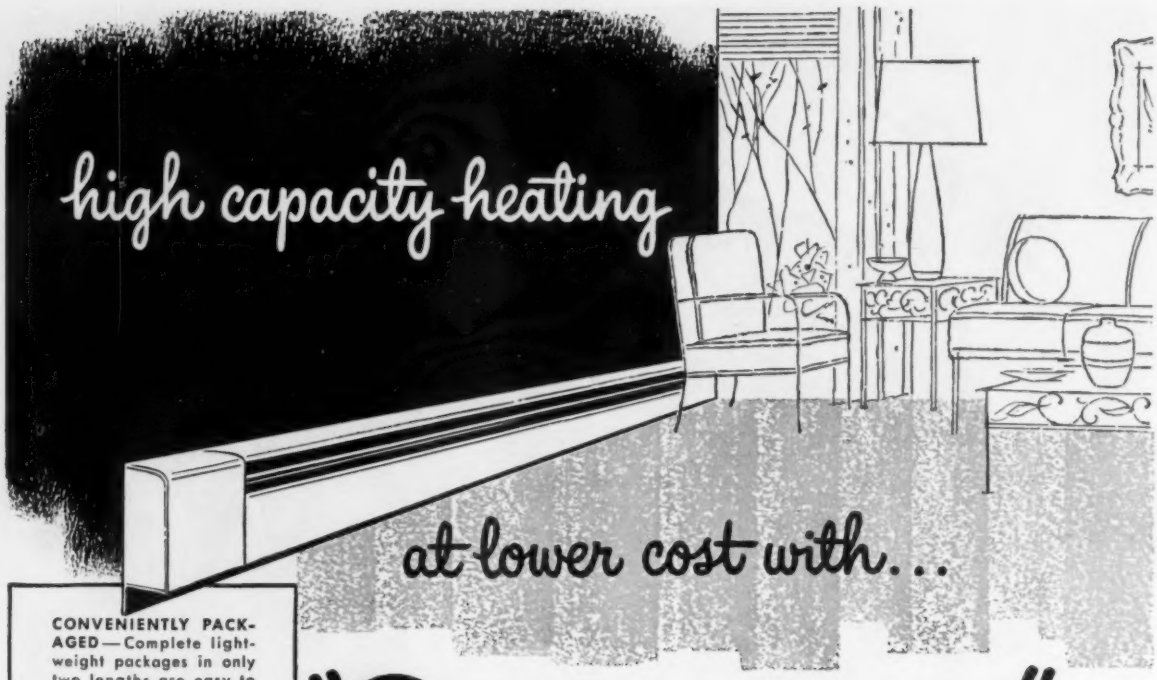
PACIFIC FITTINGS

DIVISION OF GENERAL METALS CORPORATION

Sold exclusively through wholesalers

12024 Center Street, Hollydale, California • 340 Kansas Street, San Francisco 3, California

Washington Representative: **Anderson-Beck Co., Seattle, Washington**



CONVENIENTLY PACKAGED—Complete lightweight packages in only two lengths are easy to stock . . . easy to handle on the job.

SIMPLE TO INSTALL—All components perfectly fitted . . . many simply snap in place. Dampers or air splitter optional.

"Perimaheat"

Baseboard Convectors

Advanced *Perimaheat* Baseboard design produces high efficiency heating, the result of more than 28 years of YOUNG specialized heat transfer engineering and experience.

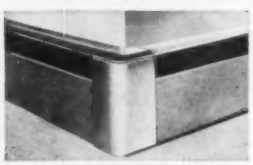
Perimaheat heating elements feature aluminum fins mechanically bonded to copper tubes to form a double-walled continuous metal heat transfer surface that produces maximum heating efficiency. Cushion strip and free-hanging elements eliminate contraction and expansion noises. Smooth, attractive *Perimaheat* Cabinets are easy to keep clean.

For further *Perimaheat* details, see your Young Representative listed in the yellow pages of your telephone directory, or mail coupon below.

JOINT COVER

RIGHT OR LEFT-HAND END CAPS

INSIDE CORNER


OUTSIDE CORNER

Perimaheat is a Young Radiator Company Trade Mark.

The Young Radiator Company is a member of the Convector Manufacturers Association and subscribes to the engineering standards of that association.

CMA

mail coupon for full details

YOUNG RADIATOR COMPANY
Dept. H-515, Racine, Wisconsin
Please send me free *Perimaheat* Baseboard Catalog.

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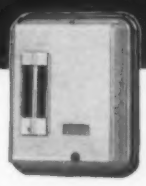
Young RADIATOR COMPANY

RACINE, WISCONSIN

Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois



JOHNSON-CONTROLLED HEAT PUMP

Insures Ideal Comfort, Cuts Heating and Cooling Costs

Year 'round air conditioning for the award-winning Roanoke Public Library* is accomplished by an application of the reverse cycle heat pump, utilizing two 40-ton refrigeration compressors. The installation is one of the first of its kind in a library building.

Precision control of this modern air conditioning system is provided by a specially engineered system of Johnson Automatic Temperature Control. Strategically located Johnson Heating-Cooling Thermostats maintain refreshing, even temperatures throughout each of the nine zones into which the building is divided. Behind the scenes, other Johnson Thermostats, Valves and related apparatus constantly keep the system in balance with outdoor temperatures.

Whether it's the spacious main reading room, a filled-to-capacity auditorium or one of the many smaller special activity rooms, there is constant comfort to satisfy the occupants. Control is so perfect that occupants never feel the need for more or less heating or cooling.

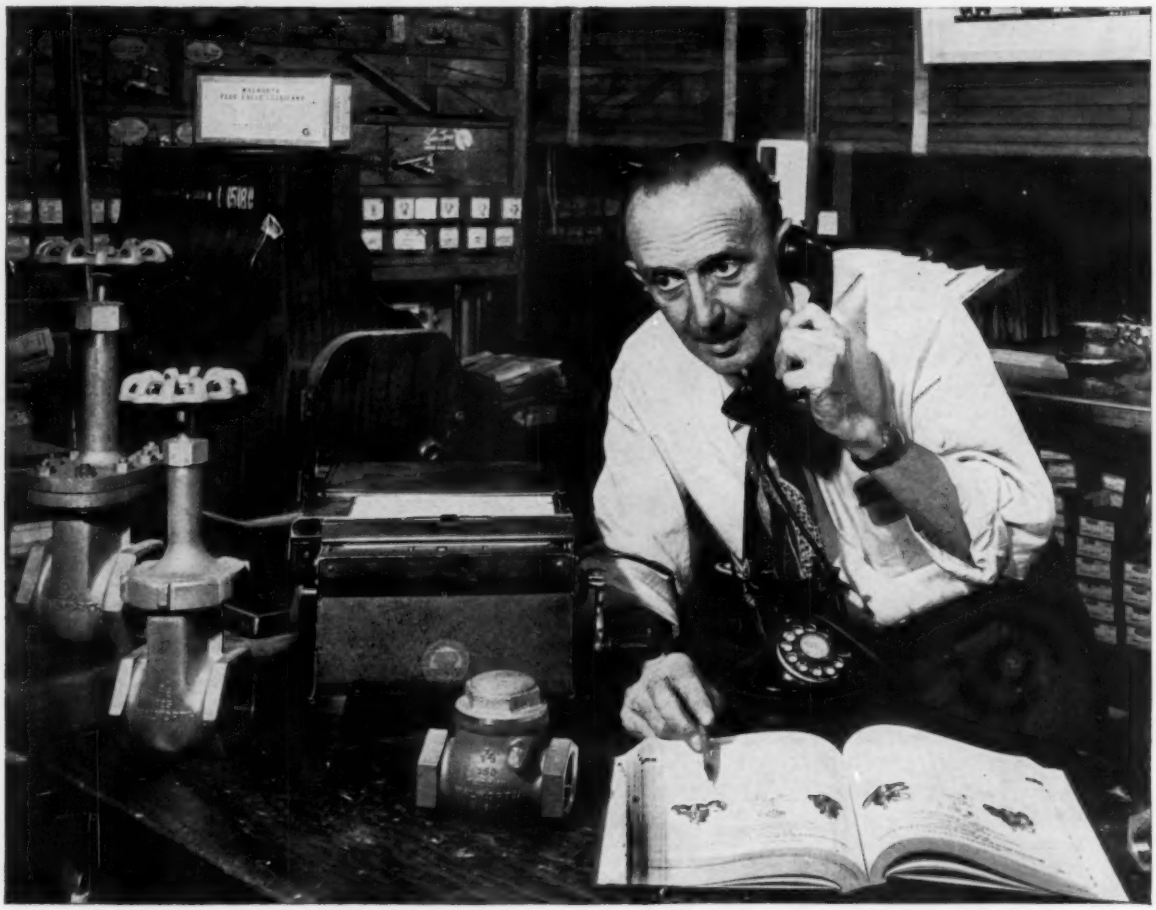
Operation of the system is completely automatic, including all heating and cooling, defrosting and indexing of the room thermostats. Added to the comfort and convenience features of Johnson Control are equally important economy advantages. The efficient control of this heat pump installation results in virtually waste-free heating and cooling performance!

Whatever your control problem—whether it involves a new or existing building, a simple or intricate system—it can be solved best by Johnson. Why don't you take advantage of the more than 70 years' experience of the nationwide Johnson organization? An engineer from a nearby Johnson branch will gladly make recommendations without obligation. JOHNSON SERVICE COMPANY, Milwaukee 2, Wisconsin. Direct Branch Offices in Principal Cities.

*Roanoke Public Library, Roanoke, Virginia. Frantz & Addkison, architects, Roanoke; Wiley & Wilson, mechanical engineers, Lynchburg, Virginia; R. H. Lowe, air conditioning contractor, Roanoke.

JOHNSON CONTROL
TEMPERATURE AIR CONDITIONING

PLANNING • MANUFACTURING • INSTALLING • SINCE 1885



*Fictitious name used to typify over 400 Walworth Distributors

Here's why it pays to do business with distributors like Mr. Hansen*

Andy Hansen is typical of Walworth Distributors throughout the nation. He has been a distributor of Walworth Valves and Fittings for years. Like Andy, the Walworth Distributor in your area provides these services and savings:

He reduces your inventory costs. He's aware of the valve and fitting needs peculiar to his area. He stocks the products that will best serve your needs. Deliveries are always prompt and economical – emergency orders can generally be delivered within hours.

He offers you application and engineering assistance. His technical experience can be invaluable in solving your particular problems. He has 50,000 Walworth products at his disposal. You can be sure that the items he recommends are exactly right for the job.

He is a double guarantee. His business depends upon providing you with the very finest products and unsurpassed service. Every valve and fitting is backed by his own reputation and that of Walworth – a complete line manufacturer.

There's a Walworth Distributor near you ready to help. Call on him today.

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valves . . . pipe fittings . . . pipe wrenches

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Performance-Rated® MOTORS

Putting Performance-Rating to work...

...is an important step in improving the performance of driven equipment. Only if the motor fits the speed, power and operating requirements of your equipment, can you be sure of top performance and trouble-free service.

Century's unusually wide range of size, speed, frame and torque characteristics makes possible countless combinations ...one of which will be precisely right for your particular application.

Choosing a Century motor, Performance-Rated to fit your job, is a matter of minutes when you use this handy Application Guide...

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- TYPE
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NOW... all the features the air conditioning industry has been looking for!

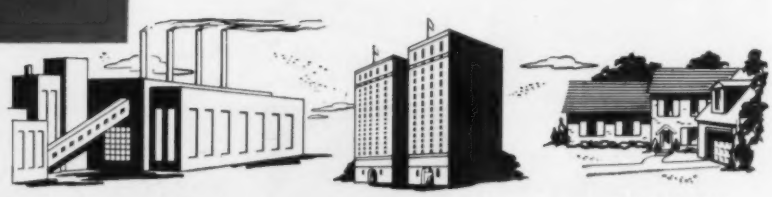
SEALMASTER'S

Rubber Mounted-Zone Hardened

BALL BEARING UNITS

Air conditioning has become one of America's fastest growing markets. It has also become one of the most competitive. Manufacturers continue to search for better and better features for their products—distinct selling advantages for their sales' outlets. SEALMASTER engineers, well schooled in the needs of the air conditioning industry, designed these new Rubber Mounted Ball Bearing Units with the problems of the air conditioning industry in mind. A Zone Hardened, Permanently Sealed SEALMASTER Ball Bearing Unit is mounted in a synthetic oil-resistant rubber ring which fits snugly in a pressed steel housing. (Cartridge units available for insertion in special and built-in housings.) The result is the quietest, smoothest performing bearing unit on the market. A plus feature for your sales story.

WRITE FOR FREE BULLETIN #1253.



INDUSTRIAL COMMERCIAL RESIDENTIAL

SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. • 47 RIDGEWAY AV., AURORA, ILL.

never before

a pneumatic thermostat like this!

The Honeywell Pneumatic Round

so technically advanced in every way that it outmodes all others!

The first completely new pneumatic thermostat since the trend to contemporary design in modern architecture!

New force-balance principle, new low-mass sensing element, new design make it the fastest responding, most accurate, best looking pneumatic thermostat on the market!

ACTUAL SIZE

so beautiful!

Modern Round Styling Complements Contemporary Interiors

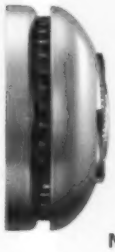
A refreshing departure from previous pneumatic thermostat design gives the Pneumatic Round pleasing style features to enhance the simplicity of the modern commercial building. Designed in the studios of Henry Dreyfuss, world-famous industrial designer, this graceful thermostat was made for today's functional interior. And its bronze-colored metal cover may be lifted off and painted to blend in with the color of the walls or furnishings.

so easy to use!

Direct-action Dial Simplifies Operation

Setting, reading and checking of performance are simplified by one easy-to-read scale that serves both the thermometer and the thermostat setting indicators.

Adjustable stops inside the thermostat let your client limit the temperature range. Or, he can lock the desired temperature setting in place. This feature is most attractive to hospitals and schools where limited authority in dictating temperature conditions may be advantageous.

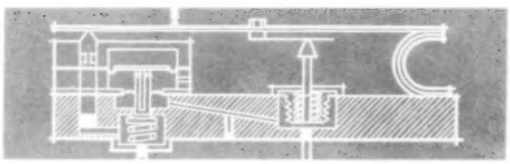


so very practical in design!

Rugged Construction Assures More-Than-Adequate Protection

A durable metal cover locks to the Pneumatic Round to guard it against shock or tampering. Other working parts are protected in the base. A grille, completely encircling the thermostat, protects inner parts yet allows free flow of air so that room temperature is accurately measured.

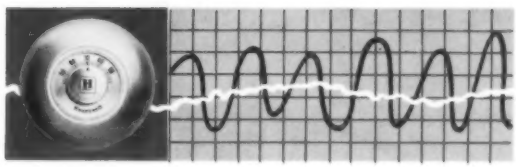
THE HONEYWELL Pneumatic Round



so ingenious in concept!

Force-balance Principle Gives Precise Modulation

By making new use of the force-balance principle—used in the finest, most accurate industrial instruments—the Pneumatic Round provides an automatic self-check on each change in control signal. Through a special signal feedback arrangement, it creates a snubber action which stabilizes the operation of the valves and dampers and makes possible the use of a low-mass, fast-acting sensing element. This results in smooth, accurate system response.



so marvelously sensitive!

Low-mass Sensing Element Makes for Fastest Response

The Honeywell Pneumatic Round is the fastest responding pneumatic thermostat on the market. The unique force-balance principle allows the use of a low-mass bimetal element. This makes the Round so sensitive that it responds almost instantly to changes in room temperature. This sharply reduces the lag in the air conditioning system response by providing for more exact modulation of the system as changes in demand occur.

so mechanically superior in every detail!

Numerous Engineering Improvements Facilitate Easy Installation and Maintenance

1 Two new flexible plastic tubes plug into main and branch air lines for simple connection. Internal springs prevent them from crimping or collapsing.

2 Calibration is accomplished quickly by turning a screw with an ordinary screwdriver.

3 A readily accessible throttling nut aids adjustment of the throttling range.

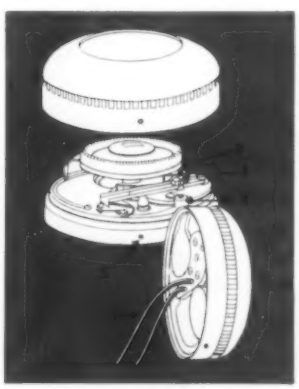
4 Branch line air pressure is easily tested by inserting a plug-in type air gauge directly into the gauge adapter.

5 Loosening two screws instantly permits removal of the cover.

6 Tight filter keeps air clean—is easily replaced if necessary.

7 Thermostat is simply constructed with fewer number of parts.

8 Fittings for either flush or surface mounting are provided with each thermostat. For modernization work a special adapter plate neatly covers hole left in wall by old thermostat.



in every room . . . in every type of commercial building . . .
wherever your plans call for the latest and
finest in temperature control equipment . . .

THE HONEYWELL

Pneumatic Round

has application features that surpass
all previous pneumatic thermostats!

IN HOSPITALS . . .

nurses need not use room lighting or flashlights to check temperature settings — Luminous "Nite-Glowing" Dials are clearly visible in total darkness. Cover available in satin chrome finish if desired.

IN SCHOOLS . . .

the simple dial setting and easy reading of the Pneumatic Round aid teachers in matching classroom temperatures with student activity. This makes for more take-home learning.

IN APARTMENTS . . .

painted to harmonize with the decor of the room, the Pneumatic Round brings residential luxury to every tenant. Easy adjustment and accurate performance provide healthful, comfortable temperatures.

IN INDUSTRIES . . .

the outstanding performance of the Pneumatic Round assures constant temperatures throughout the plant. And people working in the proper temperature can't help but produce more efficiently.

IN OFFICES . . .

the precise temperatures maintained by the Pneumatic Round promote increased office efficiency. With comfortable offices in the morning and an automatically controlled climate all day long, occupants think and work most productively.

IN HOTELS AND MOTELS

guests are sure to enjoy their stay because a thermostat controls the temperature in every room. Yet, there'll be no danger of tampering because the cover locks on. And adjustable setting screws allow your client to limit the temperature range.

AND THERE'S NO INCREASE IN PRICE FROM ORDINARY PNEUMATIC THERMOSTATS!

For further information,
call your local Honeywell office.
Or write to Minneapolis-
Honeywell Regulator Company,
Minneapolis 8, Minnesota

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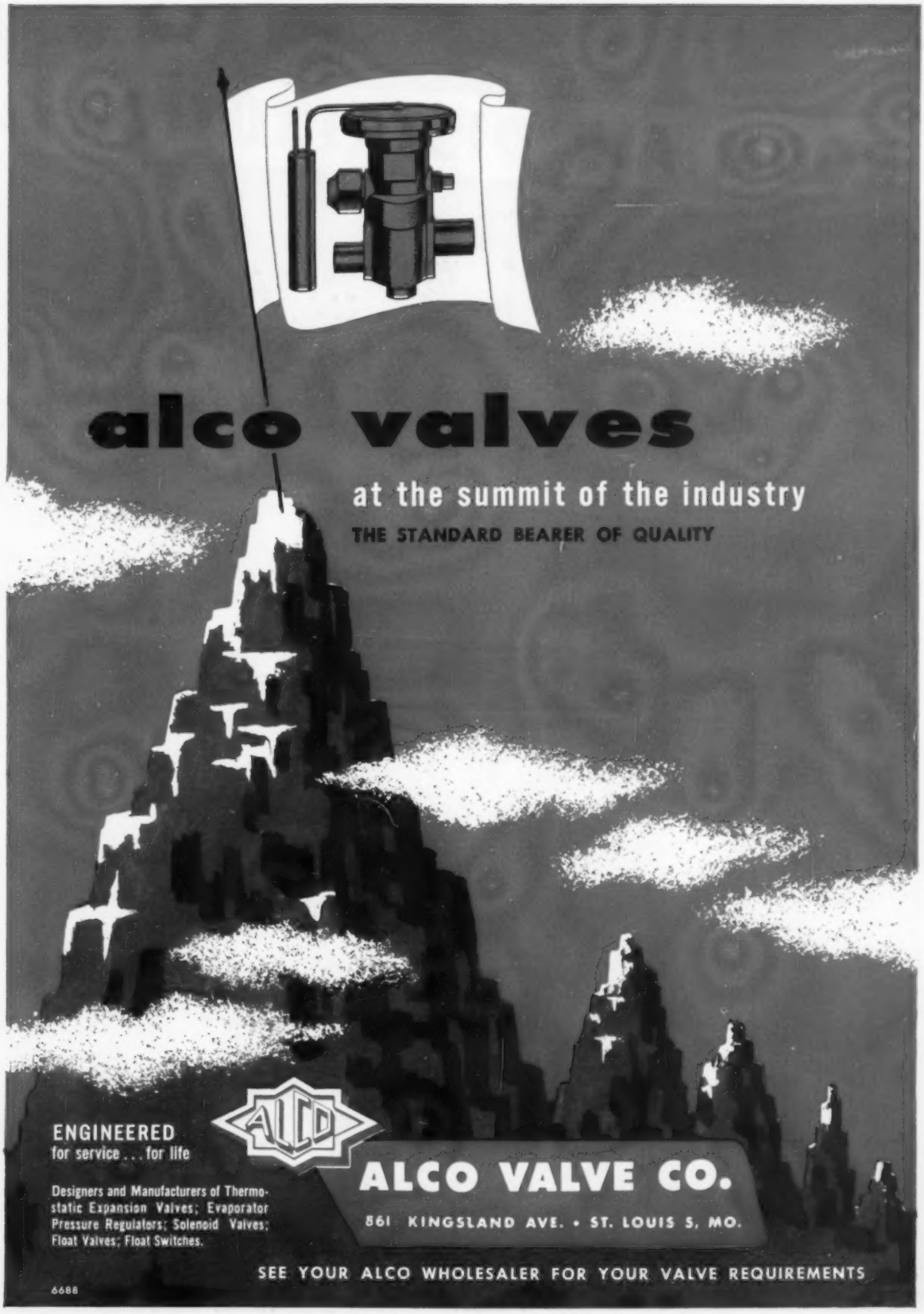
First in Controls

MINNEAPOLIS 8, MINNESOTA • TORONTO 17, ONTARIO

112 offices across the nation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at the summit of the industry
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ENGINEERED
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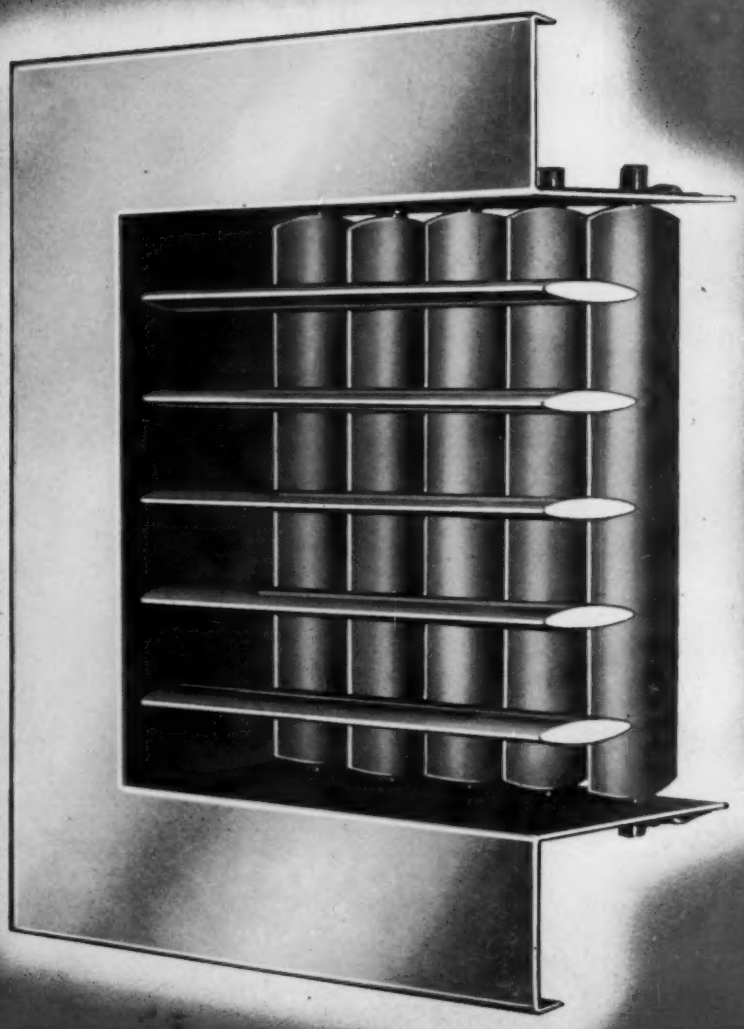
ROOM AIR DISTRIBUTION . . .

TITUS ELIMINATES INSTALLING



IS NOT COMPLICATED

50% OF GRILLE ENGINEERING & ADJUSTMENT PROBLEMS

NEW MORE AIR CONTROL BUILT-IN

By engineering MORE AIR CONTROL per square inch into each diffuser and grille . . . *right at the factory* . . . Titus simplifies all phases of grille *specification, selection, installation* and *adjustment.* Eliminates any necessity for special factory schooling or instruction at the contracting, engineering or tradesman level. Any workman can install a Titus grille without unbalancing the whole expensive system.

NEW MORE SIMPLE INSTALLATION

Install grille in 2 easy steps. (1) Fasten grille in place with screws. (2) Adjust louvers for correct air patterns. Titus *makes it easy, makes it simple* to obtain correct air patterns . . . patterns that give *maximum room comfort . . . from any air conditioning system.*

NEW MORE FLEXIBILITY OF ADJUSTMENT

Most important . . . any miscalculations that have crept in during the installation period may be simply and easily corrected by quick adjustment of streamlined Airfoil louvers. ADJUSTING IS DONE *WITHOUT* REMOVING GRILLES FROM WALLS. COSTLY TIME-CONSUMING "CALL BACKS" ARE ELIMINATED.

NEW SIMPLIFIED, FOOL PROOF DESIGN

All Titus grilles and diffusers are built under the most rigid, precision-controlled standards. They give finest air diffusing performance. Air control cannot be lost at the installation level. Titus grilles are so carefully constructed it is almost impossible to have anything but correct diffusion of air . . . no matter who installs or adjusts them.

SETS PERFORMANCE STANDARD FOR ENTIRE AIR CONDITIONING SYSTEM

Directs air where it is needed. Keeps uniform temperatures throughout room. Eliminates old-fashioned drafts . . . low level stratification. Truly controls comfort . . . *at the room level* . . . THE ONLY AREA WHERE THE UNIT'S ENTIRE HEATING OR COOLING PERFORMANCE IS JUDGED.

FREE CATALOGS

Get information on the complete line of Titus grilles now.
Order actual samples. Look at them. Hold them in your hands. Test them. See for yourself why Titus can save you money. Can give you better air diffusion performance . . . in every type of building where air conditioning is used.

TITUS MANUFACTURING CORP., WATERLOO, IOWA

Gentlemen: I wish to simplify my grille installation problems and to lower my grille installation costs. Please send me complete information on the following Titus grilles.

☐ Supply Grilles & Registers ☐ Return Air Grilles ☐ Volume Controllers
☐ Frames and Accessories ☐ Gymnasium Grilles

Name _____

Address _____

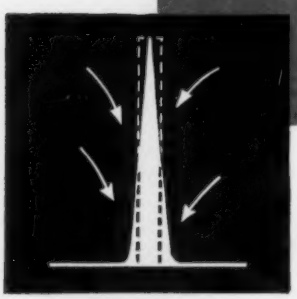
City _____ State _____

Even More Surface

per sq. ft. of face area

Even Less Air Friction

with the New AEROFIN Type B Smooth-Fin Heat Exchangers



Tapered Fin

The new smooth fin is tapered, with a wide contact base which conducts sufficient heat to make the entire fin effective transfer surface. It is no longer necessary to crimp the fin to provide the required contact area.

By eliminating the air resistance and turbulence caused by the wrinkles in the old-type coils, it is now possible to use almost twice as many fins per inch with no increase in air friction.

The resulting increase in capacity is obvious. As a consequence, these new coils offer you:

Greater capacity per square foot of face area

Lower airway resistance – less power needed to deliver the required C. F. M.

Smaller face area, due to the practical use of higher air velocities

Fewer rows of tubes for a given B.T.U. transfer in a given area

Less weight – easier handling

Better water drainage from water coils; improved venting and drainage for heating coils

Compact, sturdy design

Standardized encased units arranged for quick, economical installation

Aerofin is sold only by manufacturers of fan-system apparatus. List on request.

AEROFIN CORPORATION

SYRACUSE 1, N. Y.

SILENCE

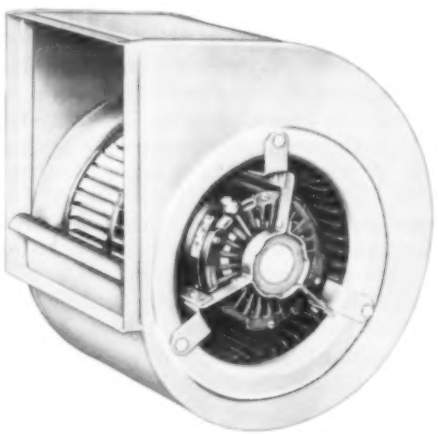
IS

GOLDEN

But perhaps you've heard about it! These days, it's difficult to keep a good thing quiet, unless of course the good thing happens to be Utility's Direct Drive Blower. This silent partner of maximum airflow is equipped with Neoprene hubs which isolate motor noise and vibration. Adaptable to the manufacture of heating, cooling, refrigeration and ventilating equipment, Direct Drive Blowers are designed by Utility engineers to keep things quiet, to make this equipment easier to sell to your customers.

Why not whisper this interesting news to your suppliers. If they'll listen to reason – and that's about the only thing they'll hear with Utility's Direct Drive Blower – you'll easily sell them on the money-making idea that silence is golden – for them and for you.

There's a lot more to the Utility story that also doesn't meet the ear. Utility Direct Drive Blowers take less space, have no unnecessary accessories and can be speed controlled easily. And while Utility's techniques are advanced, costs are not.



Get the maximum sales appeal of silent operation in the equipment you handle. Always check to see that Utility's no-noise Direct Drive Blowers are part of this equipment. Cash in on this "hush-money" with every unit you sell.

A Division of Utility Appliance Corp.

UTILITY FAN CORPORATION

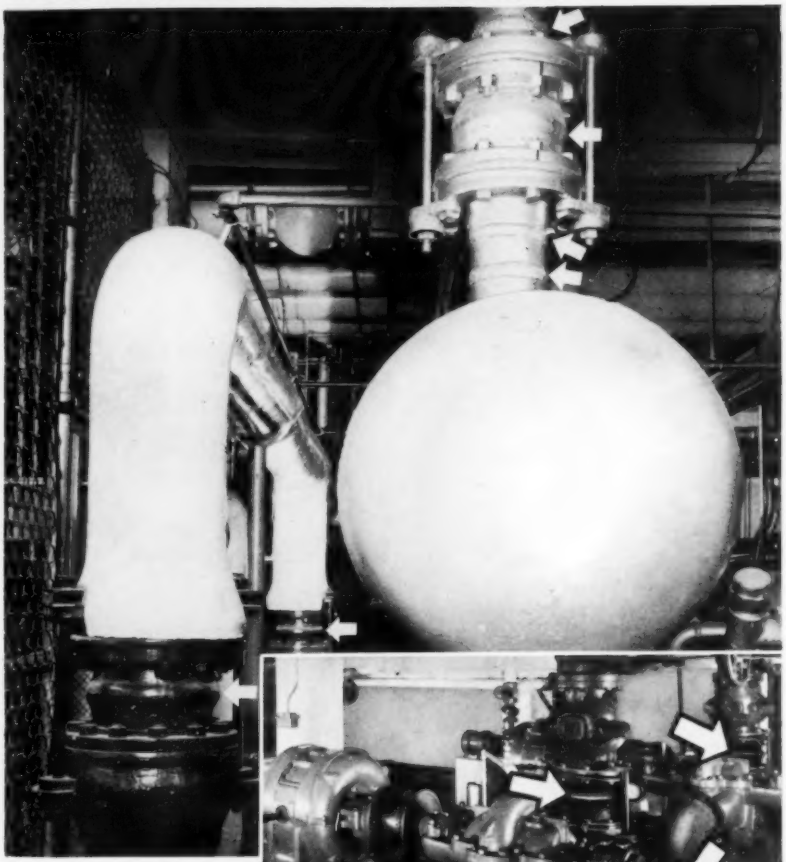
911 East 59 Street, Los Angeles 1, California

you can't match UTILITY *for product and price*

Manufacturers of heavy and standard duty blowers for heating, air conditioning and ventilating installations. Producers of blowers and blower parts for original equipment manufacturers. Write for catalogue data.

FOR SILENT, VIBRATION-FREE AIR-CONDITIONING SYSTEMS

Prevent transmission of compressor noises in circulating lines with U. S. Rubber Expansion Joints



A compressor with expansion joints on the suction and discharge lines. Suction line is at bottom, discharge line at top. Expansion joints were vulcanized to welded flanges at our factory, to handle Freon in the compressors.

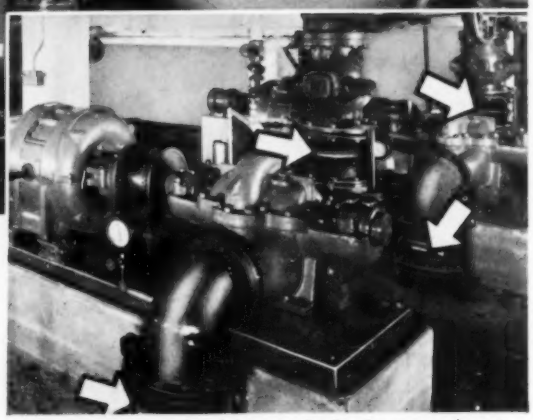


Photo shows expansion joints on the header connections to the condenser and to the cooler and on pipe lines at the circulating water pump.

These flexible rubber connections for pressure and vacuum pipe lines insulate against vibration and prevent the transmission of noise. They also offset stresses caused by expansion and contraction and misalignment. You will find U. S. Expansion Joints are standard on many of the most up-to-date air-conditioning installations.

A product of United States Rubber Company, these U. S. Expansion Joints have many applications in air conditioning: they are used for the chilled-water lines from the water chillers, and the refrigerant lines from the refrigerating compressors; also the water lines to and from the cooling towers. They are used on the header connections to the condenser and to the cooler and on pipe lines at the circulating water pump.

For handling Freon in compressors, there is a specially-designed U. S. Freon Expansion Joint.

Since they have no moving parts to wear or bind, U. S. Expansion Joints last a long time. Some are still in service after 30 years—a record unmatched by any other expansion joint! U. S. Expansion Joints will solve any pipe line problem caused by noise, vibration and misalignment. They are obtainable at any of the 27 "U. S." District Sales Offices, or write address below.

"U. S." Research perfects it..."U. S." Production builds it...U. S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

THE FIRST TOTALLY NEW FILTER DEVELOPMENT . . . IN 25 YEARS

*This is not an idle claim . . . it's a fact . . . PROVEN UNDER ACTUAL INSTALLATION AND MAINTENANCE CONDITIONS.

Make no mistake about it . . . no matter how small your filter requirements . . . or how large, here is a completely new air filter development that can absolutely cut your clean air maintenance costs in half.

NO HEAVY TENSION OIL — Evans filters do not have a messy, sticky type of adhesive that is filthy to handle and difficult to clean. It is unnecessary and is forbidden in the use of Evans filters.

CLEAN WITH TAP WATER — Evans filters can be cleaned clean in minutes with nothing ever but tap water sprayed through an ordinary garden hose nozzle. They require no expensive fireproof room. No caustic cleaning solutions or agents. This eliminates all danger in the cleaning of Evans filters.

LIGHT WEIGHT CUT LABOR COSTS — Evans filters are all aluminum. Light to handle, to carry, to pick up. In spite of airtight fitting frames, Evans filters pull quickly and easily in and out of the frames. Take much less effort, less labor to handle. No latches . . . or lugs required.

REMEMBER: Initial costs for air cleaning equipment are not the big factors or controlling factors in the cost for clean air.

IT'S OPERATING COSTS THAT YOU MUST LIVE WITH AND THAT YOU MUST CONTROL.

EVANS FILTERS GIVE YOU THAT CONTROL. MAKE IT POSSIBLE FOR YOU TO SAVE 50% ON CLEAN AIR MAINTENANCE COSTS.

- ALL ALUMINUM
- EVERY PART PRECISION MADE
- HOLD UP TO 200% MORE DUST AND LINT WITHOUT HARMFUL RESTRICTION TO AIRFLOW
- GIVES LIFETIME SERVICE

FREE CATALOG MAIL COUPON TODAY

THE GEORGE EVANS CORPORATION · MOLINE, ILLINOIS

Gentlemen: I wish to know how to cut my clean air maintenance costs in half with a filter that gives lifetime service. Please send me new illustrated catalog.

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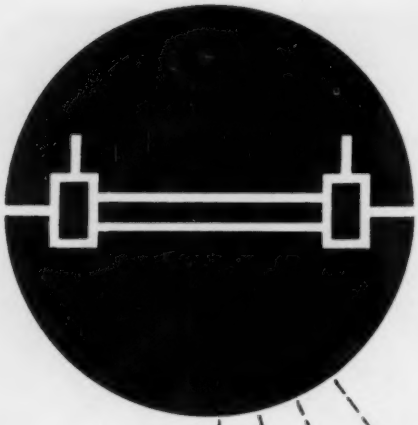
Company .....

Address .....

City ..... State .....

Evans

Lifelong AIR FILTERS



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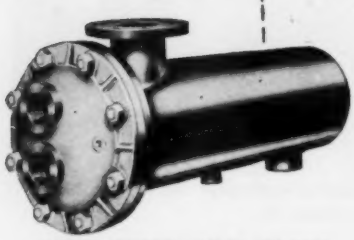
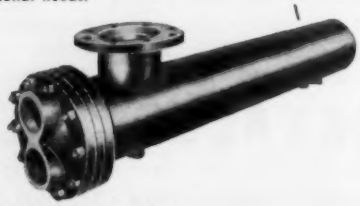
to get the most
out of heat exchange...

A DEPENDABLE LINE OF INDUSTRIAL FLUID HEATERS

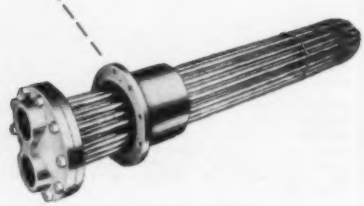
Here's the efficient answer to your industrial and commercial fluid heating requirements . . . GENERAL Heat Exchangers. You can be sure of long, troublefree service at low cost—backed by 25 years' engineering and manufacturing experience in fluid heating equipment. Get the complete story for your next installation, whether it's new construction, modernizing, or expansion. Write for Catalogs. General Fittings Company, Box 151D, East Greenwich, Rhode Island.



INSTANTANEOUS WATER HEATERS Modern hot water supply for plant wash rooms, processes, cafeterias, hospitals, and other industrial, commercial, or institutional needs.



CONVERTERS 54 sizes steam-to-water. 20 sizes water-to-water (baffle type). Capacities to 900 g.p.m.

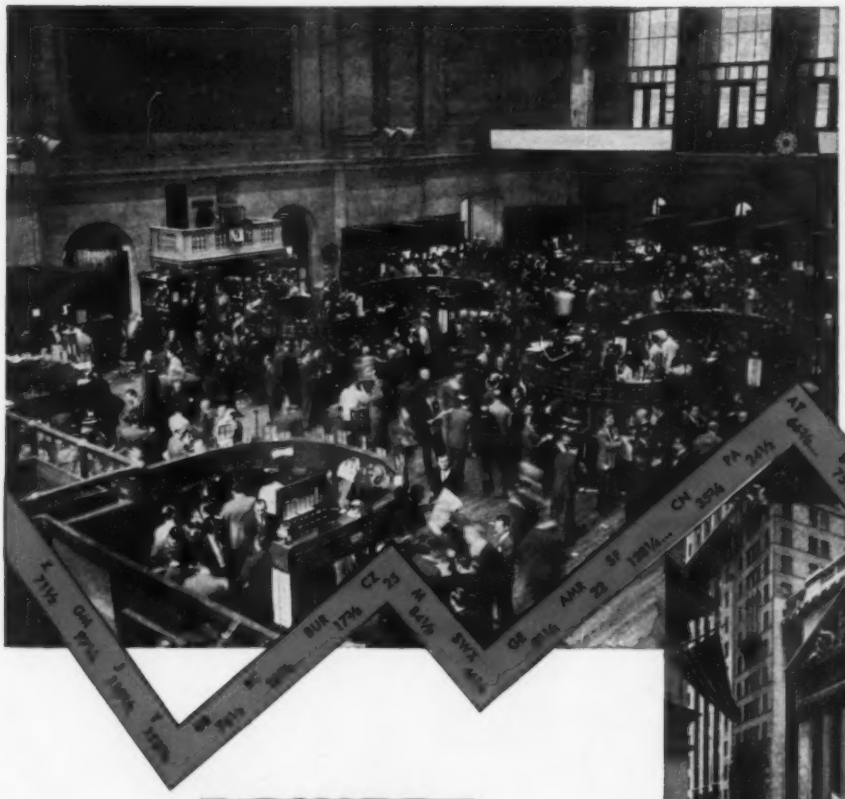


TANK-HEATING UNITS 54 sizes for all requirements.

FUEL OIL HEATERS 5 types. Oil-through-shell or oil-through-tubes, for use with steam or boiler water — discharge or suction side of oil pump — U-tube or straight tube.

GF GENERAL FITTINGS COMPANY

TANKLESS AND INSTANTANEOUS WATER HEATERS AND HEAT EXCHANGERS



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Mr. D. A. Kepler, Chief Engineer of the N.Y. Stock Exchange, in the photograph above, reports temperature is held within limits of approximately 1°F. plus or minus.

(a94)

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Abbott Laboratories • Armour Pharmaceutical Center
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Your Problems of Temperature and Humidity Control may be similar to many Powers has helped solve for the users listed above. For further information phone your nearest Powers office or write us direct.

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Offices in Over 50 Cities **THE POWERS REGULATOR COMPANY** Established 1891

Examine this new OIC valve model for 5 minutes. See how its unusual design features can lower your valve and maintenance costs.

It's an exact 2″ model of the newly designed OIC cast steel, lubricated plug valve. On test, its 6″ big brother endured 3000 full openings and closings at 425 p.s.i. pressure on solvent. It remained pressure tight, operable at low torque, and showed no sign of galling or seizing. You'll understand why, when you study the model.

See how its exclusive gland liner retains plug adjustment longer. Examine the valve's multiple seals. Operate it. Look at the design of its 4 plug grooves and see how more efficient lubricant distribution preserves the valve's primary seal. Its many life-extending features are all in the model.

Every OIC salesman has one. When he calls, ask to see it. Analyze its values. You'll be handling a model of the most modern lubricated plug valve known.

For complete advance information and specifications on the OIC lubricated plug valve line, write for Bulletin 1003.

OIC
FOUNDED 1883

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

VALVES | FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

The patented R & M electronic testing machine used to check torque of all R & M Air-Conditioning Motors . . . in all speed ranges.

Choose the power you want—from 1 to 200 horsepower.

"Weatherized" inside and out—

AT NO EXTRA COST!

NOW . . . get the torque YOU want . . . by specifying ROBBINS & MYERS!

R & M motors have not only the right construction features for air-conditioning service, but the right *torque characteristics* as well.

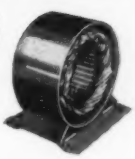
That's because we have completely eliminated guesswork in determining the starting and acceleration performance of our induction motors. Tested by a unique electronic machine over the entire speed range, each motor *shows* its own *complete* accelerating curve, including that part which is almost impossible to obtain by other methods.

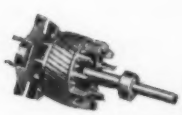
For you, this means your R & M motor will not "hang up" at some low speed—the "dips" have been designed out. And this patented speed-torque tester proves it!

And, here's something you'll want to know about *installation*. You can reconnect—*on the job*—all R & M standard 220/440 volt motors for 220 volt part-winding increment starting. Thus, only half normal starting current is drawn—without need for autotransformers or resistors.

Want more details? Write for Bulletin 400HP, showing all the advanced construction features of R & M motors. It costs you nothing, of course, to find out about the finest air-conditioning motor your money can buy!

Steel parts undercoated with baked-on "Robbinite."





Rotor and shaft assembly sprayed with special rust inhibitor.

Cast-iron parts get special anti-corrosion treatment.

Terminal box—cast-iron—gasketed; leads sealed. Repellent grease keeps moisture out of bearings.

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MOTOR DIVISION • SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

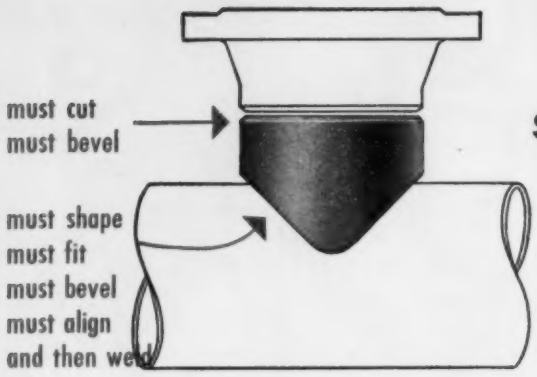
Fractional & Integral H.P. Motors & Generators

Moyno Pumps

Propellair Industrial Ventilating Equipment

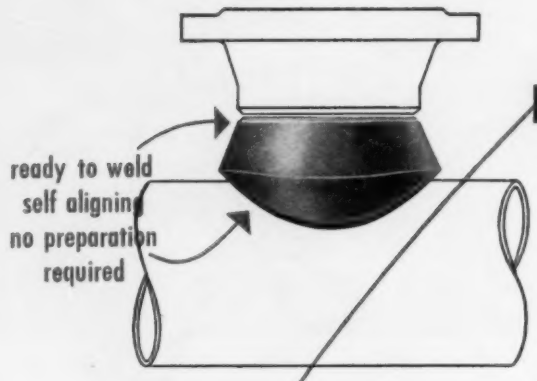
Electric Fans

Electric & Hand Hoists & Cranes



short nozzles

don't pay...



Bonney Weldolets

do!

Even on low pressure piping ... avoid non-productive preparation time ... SPECIFY and USE WELDOLETS

No joint preparation is required for *either* weld of the Weldolet, whereas considerable preparation is required for *both* welds of the miter branch construction.

The integral reinforcement of the Weldolet Welding Fitting has established it as an ideal method of constructing branch connections on high pressure and/or high temperature piping. This feature is *bonus insurance* on low pressure piping where the Weldolet is easier and more economical to use than preparing the two ends of a short unreinforced nozzle.

BONNEY

WELDING FITTINGS DIVISION

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Portmar LOW WATER LINE FIREBOX CONSTRUCTION BOILER

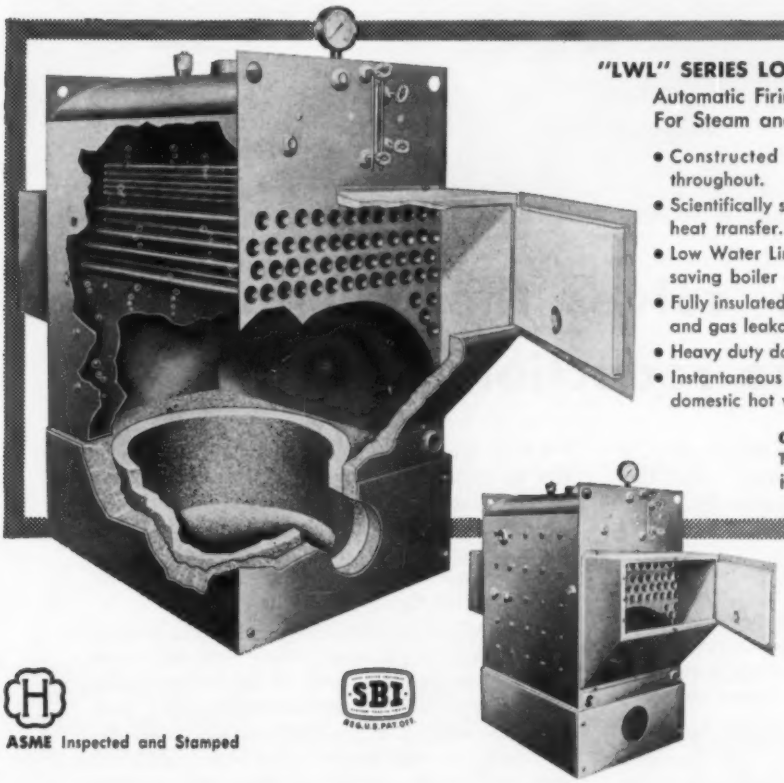
FULLY SERVES THE BIG STRUCTURES

Apartment Houses, Commercial and Public Buildings,
Industrial Plants and Institutions, Housing Projects, etc.

Portmar's wide experience in producing steel boilers of sound design and construction is an accepted fact among builders, architects, engineers and contractors.

"LWL" boilers are no exception to the Portmar rule of building trouble-free performance and long life into every square inch of steel boiler. Like all Portmar boilers, the "LWL" is rated with plenty of reserve to meet emergencies such as fluctuating loads, expansion, etc. And, of course, Portmar boilers are always *competitively priced* without sacrificing quality and high efficiency.

A boiler does not leave the Portmar plant, unless it's pressure-tested for possible defects, in accordance with ASME boiler code standards. Our successful growth has been achieved only because we have delivered guaranteed-performance boilers with plenty of built-in reserve to meet emergencies.



"LWL" SERIES LOW WATER LINE BOILER
Automatic Firing with Oil, Gas or Stoker
For Steam and Hot Water Systems

- Constructed of high quality heavy plate steel throughout.
- Scientifically staggered boiler tubes provide maximum heat transfer.
- Low Water Line makes the "LWL" a compact, space-saving boiler — overcomes low head room problems.
- Fully insulated double duty flue door prevents warping and gas leakage.
- Heavy duty door frame is of unique design.
- Instantaneous or tank type coils for year round domestic hot water.

GET IT FROM ONE SOURCE . . .
There's a Portmar boiler for every wet heat job...for the cottage or the housing project.

16 Sizes 876,000 to 10,200,000 BTU per hour
Steam 3,650 to 42,500 sq. ft.
Water 5,840 to 68,000 sq. ft.
WORKING PRESSURES: Steam 15 lbs.
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Also available for 100 lb. working pressure

ASME Inspected and Stamped

FOR FAST SPOT DELIVERIES, stocking warehouses in: Philadelphia, Penn. • Watertown, Mass. • Chicago, Ill. • New York, N. Y.

SEE YOUR JOBBER, LOCAL PORTMAR REPRESENTATIVE, OR WRITE DIRECT

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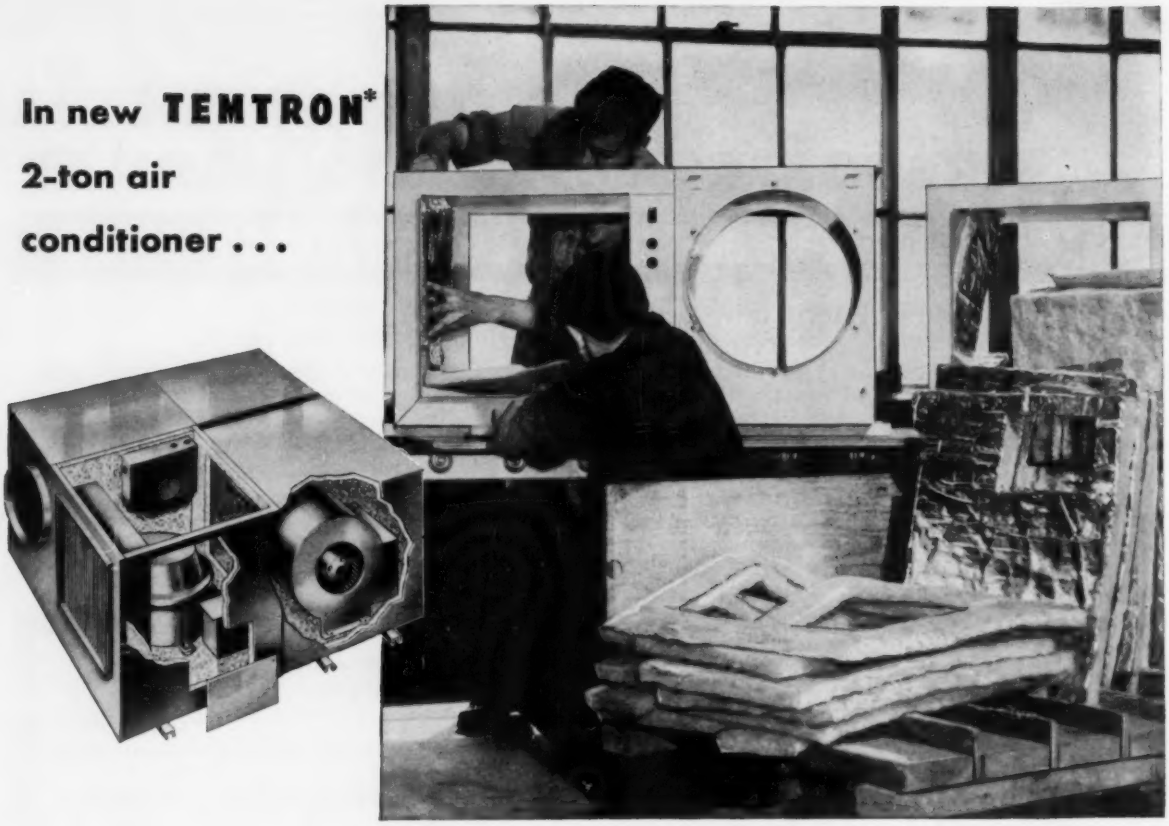
RESIDENTIAL, COMMERCIAL, INDUSTRIAL WATER HEATERS AND HEATING BOILERS • VERTICAL, HORIZONTAL TUBULAR BOILERS • ROTARY FLAME BOILERS

In new TEMTRON* 2-ton air conditioner . . .



Only Microlite® solves thermal insulation and noise reduction problems

"Here's why all the insulation in the Temtron is Microlite," says James F. Brownell, Chief Engineer of the Ultrasonic Corporation's Air Conditioning Division.

"First of all, Microlite gives us the *high thermal efficiency* we need.

"Secondly, it is an *effective sound absorber*. The 1-inch thick Microlite used in the evaporator and blower sections of the Temtron help to prevent transmission of compressor and blower noises."

To build "two tons of refrigeration with the lowest operating cost in the field," the Temtron engineers took advantage of the basic economies resulting from use of Microlite.

Chief Microlite economy is the fact that it can be handled with speed and sureness. This results from its flexibility and high tensile strength. Microlite is inherently stronger because its glass fibers are longer. These longer fibers are made possible by L·O·F Glass Fibers' exclusive "Electronic-Extrusion" process.

Other Microlite advantages are its light weight; its low space requirement; the fact that it does not support fungus growth or bacteria; that its inorganic glass fibers are non-combustible; that it resists settling, is fire-resistant and moisture-resistant; its resilience, which permits compression packaging—saves shipping and storage space.

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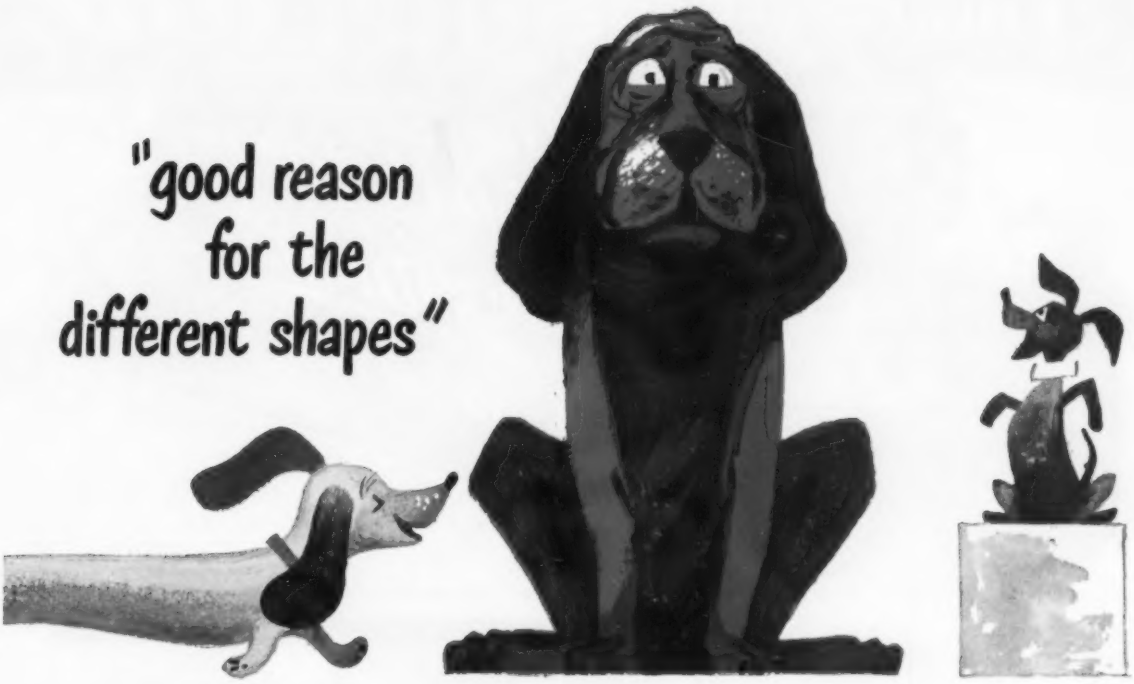
L·O·F GLASS FIBERS

FREE: Send for literature giving full information about Microlite. Write L·O·F Glass Fibers Company, Dept. 39-85, 1810 Madison Avenue, Toledo 1, Ohio.

L·O·F GLASS FIBERS COMPANY
TOLEDO 1, OHIO

Makers of glass fibers by the exclusive "Electronic-Extrusion" process

"good reason for the different shapes"



UTILITY'S HORIZONTAL AND VERTICAL FURNACES

No matter where, no matter why, there's a specially-designed Utility forced-air furnace to fit the job. Utility's engineers have created units that operate just as effectively in horizontal or vertical positions.

For space-saving efficiency, where quality counts, Utility's vertical furnace takes honors. In capacities of 70, 85, 100, 135, 165 and 200,000 BTU, it can be installed in closet, alcove or service porch.

Where there's seemingly no room at all, any nook or cranny will do for Utility's horizontal furnace. It works equally well from a spot in the attic, under the floor, under the staircase or even suspended from the ceiling. This is the one you choose when a remodeling job or new home has utilized every bit of floor space for living.

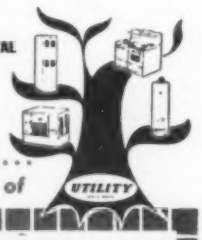
For the newest and most economical perimeter method, Utility has engineered 70,000 and 105,000 BTU counterflow furnaces for installation with minimum amount of duct work.

Whatever the shape, these furnaces have automatic controls, carry a certificate of guarantee and are completely self-contained. All AGA approved.

GAFFERS & SATTLER And OCCIDENTAL
Automatic Gas Ranges

UTILITY
Furnaces • Air Conditioners
Air Coolers • Water Heaters

a happier living family tree . . .
all branches of



See the complete UTILITY heating and air conditioning line now

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4851 S. Alameda St. • Los Angeles 58, Calif.

Please send me full information on:

☐ Utility Automatic Heating and Air Conditioning Equipment
☐ Utility Cooling Equipment
☐ Utility Automatic Gas Water Heaters

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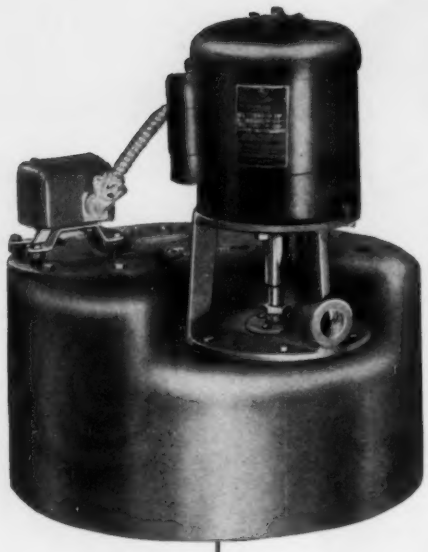


For Top Performance - SKIDMORE HAS NO EQUAL!

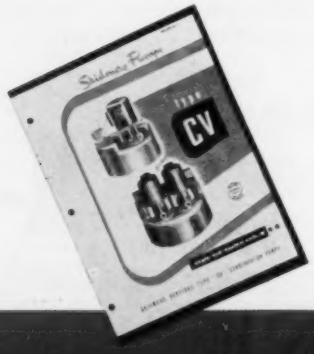
"CV"
VERTICAL PUMP
Single unit
Duplex units are built with either the two float switches or automatic alternator.

The Skidmore "CV" Vertical Pump can do the job — in less space and at lower cost! Its top performance has earned the respect and confidence of the critical engineer and contractor. Pump is bronze fitted throughout . . . shaft is stainless steel . . . self lubricating bronze bearing directly above impeller insures proper alignment and longer service.

CHECK THESE ADVANTAGES

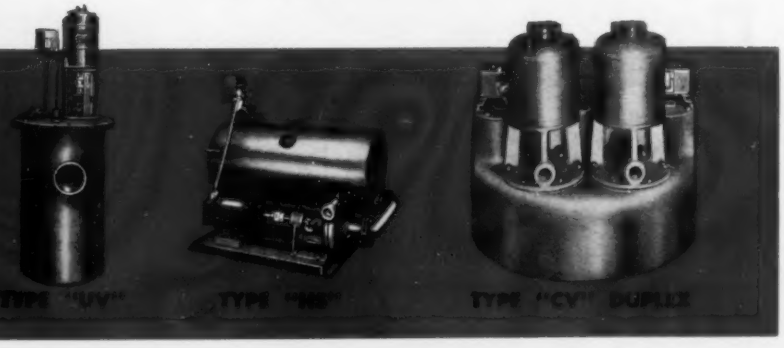
- **Available in capacity range from 500 to 10,000 sq. ft. E.D.R. and discharge pressures from 10 to 40 lbs.**
- **No close tolerance or moving parts to wear — efficiency maintained.**
- **Inspected easily, without disturbing piping.**
- **Compact and rigid — requires only a space 15" x 15" x 22" for unit shown above.**
- **Receiver can be installed on floor level or in pit — has lowest possible receiver inlet opening.**
- **Cast iron receiver — for longer wear.**

NEW BULLETIN
Complete engineering data and capacity tables are yours for the asking . . . send for bulletin No. 21.



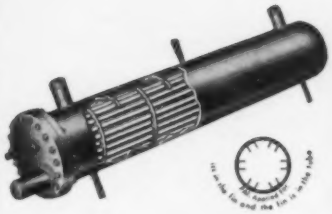
SKIDMORE CORPORATION, ST. JOSEPH, MICHIGAN

SKIDMORE PUMPS



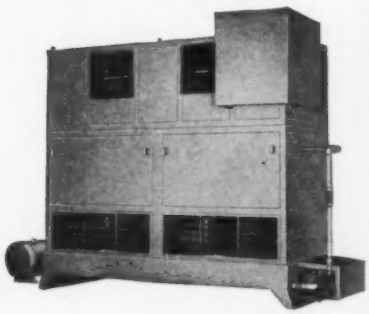
KENNARD ENGINEERED PRODUCTS

AIR CONDITIONING BLOWER UNITS
13 Sizes. 300 to 21,600 CFM. Horizontal or Vertical

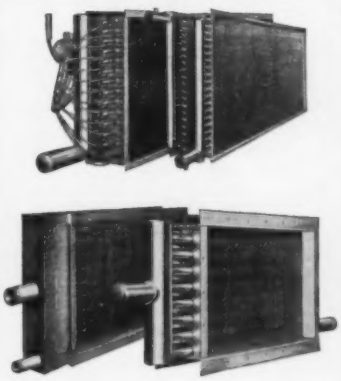


LIQUID CHILLERS
Direct Expansion Type.
Sizes 2 to 200 tons.

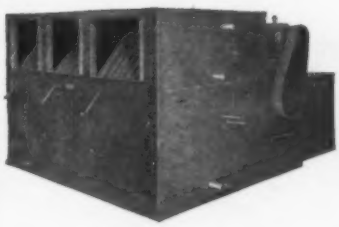
HEATING & VENTILATING UNITS
Air Volumes 300 to 28,800 CFM.



EVAPORATIVE CONDENSERS
Outdoor-Indoor
Model EC. 15 to 75 tons.
Model EK. 3, 5, 7½, 10 & 15 tons.

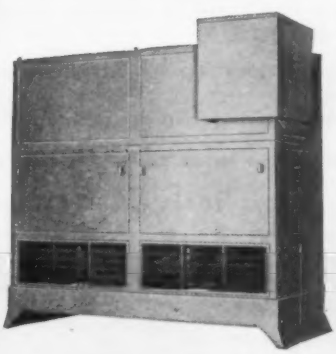


FINNED COILS
Cooling or Heating. Sizes from 4 to 24 tubes wide and up to 120 inches Finned Length.



MULTI-ZONE UNITS
6 Sizes. Cooling Coil Face Areas up to 36 sq. ft.

WATER SAVER
Fiberglas reinforced plastic cabinet and sump. Model QT.
3 and 5 ton sizes.



COOLING TOWERS
Outdoor-Indoor.
Model CT. 15 to 75 tons.

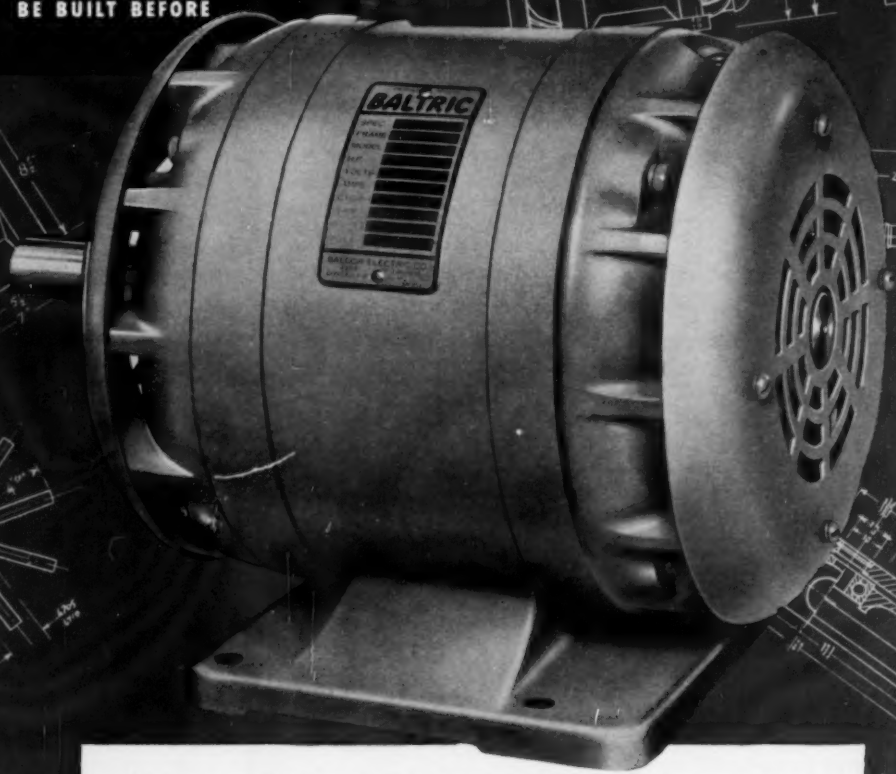
COOLING TOWERS
Outdoor-Indoor in stock.
Model KT. 5 sizes, 3 to 16 tons.

Air Conditioning Equipment

KENNARD CORP.
1817 S. HANLEY ROAD
ST. LOUIS 17, MO.

BALTRIC...

THE MOTOR THAT COULDN'T BE BUILT BEFORE



Now, in a complete line of totally enclosed motors, Baltric brings you the best answer yet to your motor problems. Less weight . . . less bulk . . . better performance, are the results of advanced engineering and new and better materials.

The new Baltric Motors pack much more power per ounce . . . permit applications and installations of greater versatility. Simple in design, rugged, yet compact and dependable, Baltric does a better job in less space than old-style motors. Baltric is a better bet for every use.

Baltric Motors are available in a complete range of models, ⅛ h. p., through 5 h. p., squirrel cage induction type, both polyphase and single phase. Baltric Motors can also be engineered to meet your special mechanical and electrical requirements.

Original *Streamcooled* Baldor Motors Available—Built to Former NEMA Standards

ALL BALTRIC MOTORS TOTALLY ENCLOSED AND *STREAMCOOLED*

BE55-3

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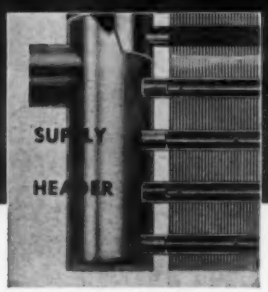
announcing...

Nesbitt

series T surface with

Trombone

steam distributing tubes



Eliminates stratification on all surface lengths under reduced steam supply ...assures uniform temperature distribution...improves freeze-up protection

Trombone shaped tubes offer the most significant improvement in steam distribution since the advent of steam distributing tube surface pioneered and developed by Nesbitt.

With condensing tubes paired in serpentine fashion, the trombone distributing tube (discharging steam through orifices spaced along its entire length) serves two adjacent condensing tubes from a single supply header connection. Steam must traverse the full length of the trombone tube (thus the full length of the surface) before reversing direction, as the demand increases, to serve the second leg of the tube. Even the smallest amounts of steam—*entering only half the conventional number of tubes*—are made to travel *twice* as far across the coil length and to contact *twice* the surface area.

Nesbitt Series T Surface is unmatched for applications requiring uniform steam distribution under modulating valve control (heating and ventilating apparatus), and for those demanding freeze-up protection (preheating).

Available in two types (TS sections have steam and condensate connections at the same end, TO sections at opposite ends), one and two row depths, with aluminum or copper fins, in finned lengths from 12″ to 120″.

Send for details in Publication 305

Nesbitt

HEATING AND COOLING SURFACE

Made and Sold by John J. Nesbitt, Inc., Philadelphia 36, Pa.

Representatives in principal cities—see telephone directory

Hotel Fontainebleau — vacation landmark of Miami Beach, Florida. Griffen Industries, Inc., ventilation contractor; Taylor Construction Co., general contractors; Morris Lapidus, architect; and John K. Sasnett, mechanical engineer.

"BUFFALO FANS" contribute to the comfort of the *fabulous* FONTAINEBLEAU

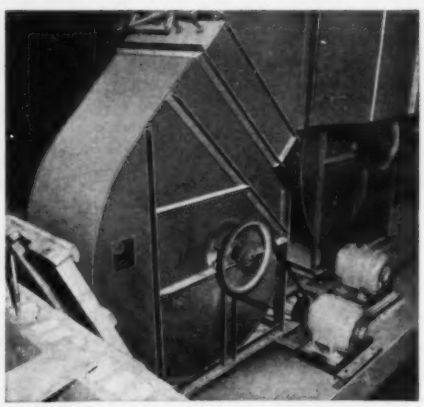
For the discriminating sun-and-fun seeker, the strikingly beautiful and luxurious new Hotel Fontainebleau on Miami Beach is the last word in elegance.

No comfort or health facility was overlooked in planning this fine hotel. The large, modern kitchens, for example, enjoy fresh, cooling air at all times, thanks to the "Buffalo" Type BL Limit-Load Ventilating Fans shown at right.

Says Charles P. Little, Chief Engineer of the Fontainebleau: "It's a real satisfaction to have such dependable equipment as these 'Buffalo' Fans. They have lived up to every performance specification. They're doing a big air moving job, keeping their zones thoroughly ventilated at all times, and doing it with so little noise and attention, you almost forget they're there."

For air results like this, specify "Buffalo", the "Q" Factor* Fans with a 78 year history of top performance.

** The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*



These two "Buffalo" Type BL Ventilating Fans keep the air of the Fontainebleau kitchens fresh and cool.

"Buffalo"

BUFFALO FORGE COMPANY

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PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

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ENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

Why should YOU stock circulator couplings?

Since new Dunham Hot Water Circulators have a *single* spring coupling that never wears out under normal conditions, you can forget about stocking replacement couplings or replacing them! The single spring coupling in every Dunham Circulator is guaranteed for the lifetime of the circulator. But this is just one of the many reasons for the rapid rise in popularity of these compact, quiet circulators.

Dynetrically balanced, one-piece impeller is vibrationless at full rated capacity. Weep hole construction between self-centering, field replaceable seals and extra-large oil reservoir prevents water contamination of bearing lubrication section. Special, *brand-name* motor has built-in overload protection.

Dunham Circulators are easy to install, too . . . in horizontal or vertical pipes . . . in supply mains or return lines . . . regardless of boiler position. For further information on the Dunham complete hot water line, clip and mail the coupon.

NEW DUNHAM CIRCULATOR
Standard and high head capacities

DUNHAM **HOT WATER HEATING**

RADIATION • CONTROLS • UNIT HEATERS • PUMPS • SPECIALTIES

QUALITY FIRST FOR OVER FIFTY YEARS

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Send complete Hot Water Line Literature.

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HENRY ASME relief valves

for Extra Capacity Extra Safety

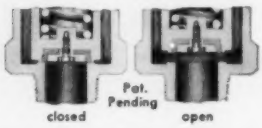
ASME
NB National Board Certified

All Henry Relief Valves in the sizes and types listed below are constructed in accordance with the standards of the ASME. In addition these valves are stamped NB to indicate National Board Certification as to capacities.

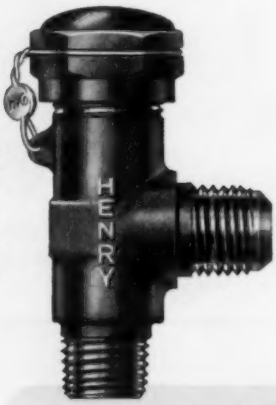
Type 523 Straight-Through Relief Valves

FOR FREON AND SIMILAR REFRIGERANTS

This relief valve has the Henry "Controlled Cushion" cup seat disc construction which prevents deformation of sealing ring and assures consistent operation. This design provides positive relief at predetermined set pressures. Brass construction. Sizes (inlet x outlet) ½" M.P.T. x ⅜" Flare; ½" F.P.T. x ½" F.P.T.; ¾" F.P.T. x ¾" F.P.T.; and 1" F.P.T. x 1" F.P.T.

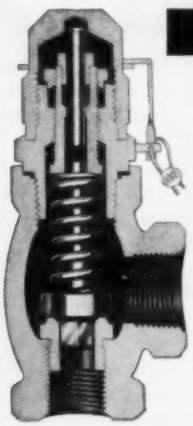


"Controlled cushion" cup seat disc construction



Type 52 Angle Relief Valve

This forged brass valve is available in sizes (inlet x outlet) ½" M.P.T. x ⅜" Flare and ⅝" O.D.S. x ⅜" O.D.S.



FOR AMMONIA

Angle Relief Valve

Has soft metal alloy seat and push rod for emergency reseating. Stainless steel trim. Sizes (inlet x outlet) ½" F.P.T. x ¾" F.P.T.; ¾" F.P.T. x 1" F.P.T.; and 1" F.P.T. x 1¼" F.P.T.

All the above valves can be furnished at any desired pressure setting in the range of 50-350 P.S.I.

Write us for data sheet #AE-1303 showing new increased capacity ratings of these Henry relief valves.

See your Henry wholesaler for these certified relief valves.

HENRY VALVE CO.

Melrose Park, Ill. (Chicago Suburb)
Cable: HEVALCO, MELROSE PARK, ILLINOIS

Specialized Manufacturers of the Complete Line of Relief Valves for Refrigeration and Air Conditioning

HENRY VALVE CO. CONTROLLING FLOW SINCE 1914

Run SERVEL WATER CHILLERS on waste heat or waste steam!

Here's how to provide low-cost chilled water for your cooling needs

If you're letting waste heat or steam "go up in smoke," you're losing your cheapest source of chilled water.

Servel WATER CHILLERS utilize these waste products from any source to provide chilled water at *controlled* temperatures . . . chilled water you can use for industrial cooling, process cooling, or air conditioning in your plant.

These efficient Servel cooling units have no moving parts. They give you vibration-free operation and low upkeep. That's because Servel water chillers use an exclusive, modern absorption principle. No heavy-duty wiring required.

What's more, Servel water chillers are compact in size . . . and have low floor loading. That means you can put single or multiple installations in the most advantageous locations . . . on the roof, in the basement, or on any floor in between . . . even in a separate building.

Check these advantages against your cooling needs. Your Servel dealer will gladly supply details and engineering help. Or mail coupon today.

SERVEL WATER CHILLERS serve a wide variety of industries

1. Beverage Industry
2. Metal Plating Industry
3. Aluminum Industry
4. Steel Industry
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6. Food Industry
7. Petroleum Industry
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Please send me specifications and full information on Servel water chillers.

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Firm_____

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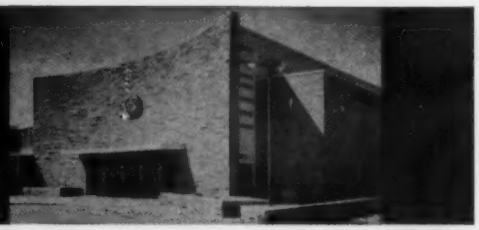
City_____ Zone_____

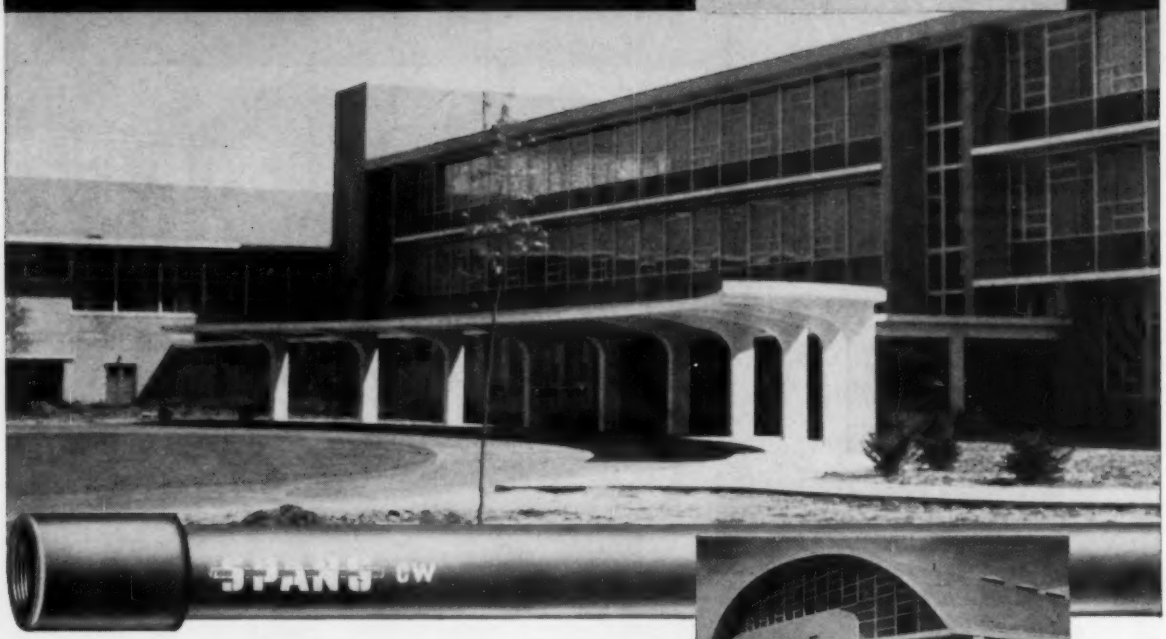
County_____ State_____

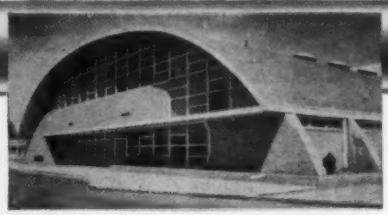
"Thanks to the 100% performance of SPANG® CW Steel Pipe,



the entire construction job has been and will be a better one!"

—says John F. Miles, Heating and Ventilating Contractor for Chambersburg Area Joint Senior High School, Chambersburg, Penna.





Owner: Chambersburg Area Joint School Board, Chambersburg, Penna. • **Architects:** Lawrie & Green, Harrisburg, Penna. • **General Contractors:** H. B. Alexander & Son, Inc., Harrisburg, Penna. • **Heating and Ventilating Contractor:** John F. Miles, Kulpmont, Penna. • **Spang Distributor:** Busser Supply Company, Lewisburg, Penna.

Over 20,000 ft. of SPANG CW Steel Pipe have been installed to create a low-pressure steam radiation heating system at the $3,000,000 Chambersburg Area Joint Senior High School, the biggest and most modern high school in rural Pennsylvania. This system will serve not only classrooms, shops, labs, library, offices and cafeteria, but also the 1500-seat auditorium and the three-unit gymnasium.

About the SPANG CW Steel Pipe installation, Heating and Ventilating Superintendent Frank Maslo says: "Because of the high quality of SPANG CW, we had no delays due to faults, brittleness or splits. We kept the job going on time with no headaches. SPANG CW is easy to thread, and this saved us time and money, as we didn't have a single die breakage.

"Our men commented about how easy SPANG CW was to cut and how clean the weld cuts were. Every cut was a perfect one. We had no defective or twisted pipe on this job—an indication of quality at the factory and in the distribution, too."

Mr. Miles stated: "We've never had a single complaint on a SPANG installation. It's definitely a *top-grade* product. Our experience indicates there isn't a better pipe on the market."

The Chambersburg report is typical of SPANG's performance in the field. It's the *quality-control* features of SPANG's manufacture that make SPANG CW a consistently uniform, *top-grade* pipe. You can get top performance, too, with SPANG CW in any kind of plumbing, heating, air conditioning, radiant heating or snow-melting installation. Write for complete information and the name of your nearest SPANG Distributor.

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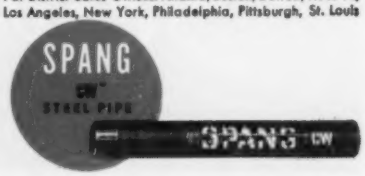
DIVISION OF THE NATIONAL SUPPLY COMPANY

General Sales Office: Two Gateway Center, Pittsburgh, Pa. District Sales Offices: Atlanta, Boston, Detroit, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis



For heating or ventilating new or existing offices, stores, schools or public buildings

Modine Cabinet Units—

so efficient, so versatile, so practical

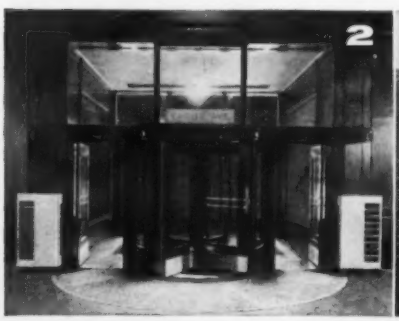
NOTHING can match the performance, flexibility and economy of a Modine Cabinet Unit when it comes to heating, cooling and ventilating. It's the modern way to year 'round comfort yet costs less to install than a unit ventilator. Recessed in the wall or concealed behind a partition or false ceiling to conserve space, a Modine Cabinet Unit provides quick, positive, quiet distribution of warm or cool air for rooms, entrances and corridors of all sizes.

Choose from five models—120 to 640 Edr. Some heat with hot water, cool with chilled water . . . others use hot water or steam for heating only. Find out how one smartly-styled Modine Cabinet Unit can do the job of two or three old-fashioned, unsightly radiators—do it better for less. Call the Modine representative listed in your classified phone book or write for Bulletin 552—Modine Manufacturing Co. 1509 DeKoven Ave., Racine, Wis.

1. Impressive modern executive office uses completely concealed Type FT cabinet unit.
2. Entrance way of large department store has two Type FE cabinet units.
2. School hallway features recessed Type BT unit with plenum base.
4. Airport promenade utilizes Type BF cabinet units with plenum base.

Modine
CABINET UNITS

C-1281



"What should I put on the ducts?"

"Which ducts require thermal insulation?"

"What kind of acoustical treatment do ducts require?"

"What are the fastest, cheapest ways to insulate ducts?"

"Do high velocity ducts require special treatment?"

Got any doubts about insulating ducts?

Write for free "HOW-TO-DO-IT" BOOKLET!

Proper thermal and acoustical treatment of ducts is absolutely vital to the success of air conditioning jobs. Recognizing the need for an authoritative "how-to-do-it" booklet, Gustin-Bacon gathered the facts and published them last year. Since that time, popular demand has caused us to reprint the booklet 4 times. It is being used by many manufacturers of air conditioning and combination units as a dealer training piece.

So don't fail to write for your free copy if you have any doubts about when, where and why to insulate ducts. It will make your job a good deal easier—and a great deal more profitable!

WRITE FOR YOUR FREE COPY TODAY!

This authoritative booklet has been prepared by Gustin-Bacon, manufacturers of Ultralite Duct Insulation (thermal) and Ultralite Duct Liner (acoustical). These unique insulations of long glass fibers are specifically designed for air conditioning application. In this booklet, Gustin-Bacon shares with you its know-how acquired in 10 years of service to the air conditioning industry.

For on-the-spot information and delivery of Ultralite Duct Insulation and Duct Liner, we invite you to get in touch with your local Ultralite distributor. You'll find him listed in the Yellow Pages under "Gustin-Bacon Insulations" in 57 cities and he maintains local stocks to give you prompt delivery when and where you need it.

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220 W. 10th St., Kansas City, Missouri

CASING ENHANCES LOW APPEARANCE OF LOWEST SILHOUETTE COOLING TOWER

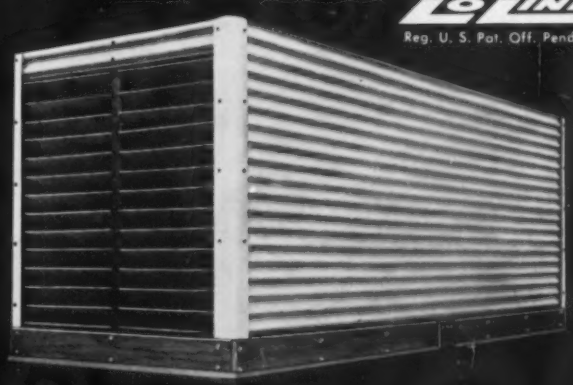
The Pritchard *LOLINE* Cooling Tower is the lowest tower of 75 tons capacity and up now available. And the casing on this new tower has been carefully designed to enhance this low appearance. Corrugated asbestos cement board panels are *horizontally* installed to give low, architecturally perfect lines to the tower. Even the corners are of asbestos board and are designed to add to the attractive appearance.

FEATURES UNIQUE IN SILHOUETTE TOWER CONSTRUCTION

- New Pritchard framework design.
- Special water piping arrangement.
- New ease in installation and maintenance.
- Lower pumping head and power usage.
- New design, nail-less filling.
- Individually removable asbestos louvers.
- Trouble-free mechanical equipment.

GET THE WHOLE PICTURE!

Send for your complimentary copy of the new Pritchard *LO LINE* Cooling Tower bulletin. It describes each construction feature in detail, with accompanying illustrations, capacities and specifications, cross-sectional drawing. Send for it today.



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COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

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OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 462, 4625 Roanoke Parkway, Kansas City 12, Mo.

It's good, solid business sense! Before placing an electric-welded steel tube order there are certain things you want to know about your supplier.

For example, you want to know about his reputation, the quality of his products, the extent of his facilities and his adherence to delivery dates. Equally important is the reliability of his quotations, his plant capacity, his service facilities and the ability of his sales organization to serve you.

You'll find that in each of these respects Wolverine is tops —all the way. You'll find, too, that Qualitube*, Wolverine's electric-welded steel tube, fully reflects these qualities— is *just what you are looking for.* Put us to the test —specify Wolverine on your next order. Write, too, for a copy of the Wolverine Steel Tube Catalog.

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*REG. U.S. PAT. OFF.

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DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

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Sodium sulphate • Asbestos fiber & cement mix • Green liquor •
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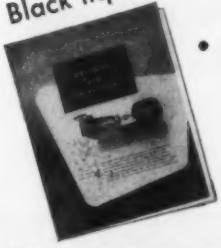
Tomato puree • Propanol • Soap liquor • Cane juice • Aqueous lime • Coke oven oil •
• Paper stock • Waste sulphite liquor • Alkylaryl sulfonate • Sugar liquor • Vinyl pyridine
• Saturated brine • Grape juice • Tomato juice • Press liquor • Calcium bisulphite • Melt
Phenolized ammonia • Ammonia liquor • Sulphuric acid • Paraffine oil and water • Sludge
• Milk waste • Gritty water • Cane syrup • Lime & soda solution • Cachaza • Clear juice
White water • Mineral oil • Chromic acid
Brine • Vegetable oil • Licorice liquor •
• River water • Benzine thinner • Mash
Methylene chloride • Sodium hydroxide
Sizing solution • Alcohol •
• Steep soda • Caustic soda
Black liquor • Ethylene glycol
• Fuel oil • Furfural
• Condensate •

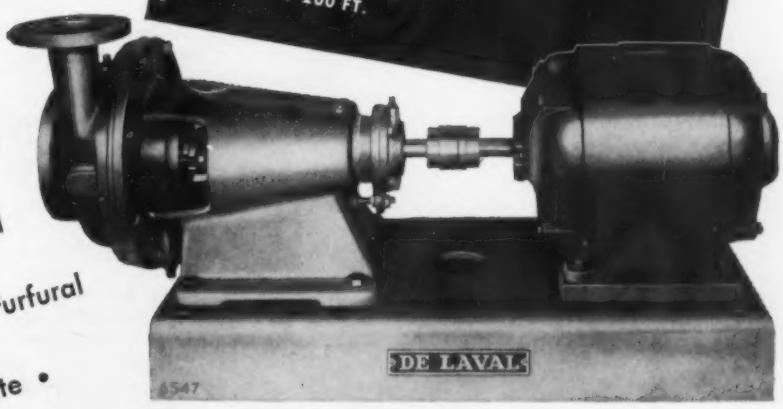


WRITE FOR BULLETIN 1125-B

One pump handles all these liquids...

DE LAVAL CPO PROCESS PUMP

CAPACITIES TO 2,000 GPM
HEADS TO 200 FT.



DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY
871 *Nottingham Way, Trenton 2, New Jersey*

DL 281

These Crane valves stay tight on soap oils and fatty acids

THE CASE HISTORY—Leakage through valve seats in raw materials supply lines posed a serious problem for Davies-Young Soap Co., Dayton—makers of various type soaps and cleaning fluids. Unwanted materials leaking past metering stations would infiltrate processing vats.

Four different makes of valves were tried before these Crane valves were installed. With all four, results were the same—seat leakage developed quickly; the valves lasted no more than 4 to 8 weeks.

Valve replacement costs were a factor on top of production losses.

The condition was remedied on installation of Crane No. 1670 Ni-Resist cast iron valves in January 1954. Eighteen months later—with no piping maintenance and no shutdowns whatsoever—the Crane valves are still holding tight. And they show no deteriorating effects from the fluids handled.

Crane Ni-Resist gates don't *look* much different from similar valves of other makes. Their difference is in properly designed, accurately finished seating of 18-8 SMo stainless steel—plus the *extra* erosion-corrosion resistance of Ni-Resist bodies and bonnets cast by Crane. Thrifty buyers know these valves have no "equal" for handling many hard-to-hold, mildly corrosive fluids.

You should have the new folder (AD2047) on these valves. Ask your Crane Representative for a copy, or write to Crane Co., General Offices, Chicago 5, Ill. Branches and Wholesalers serving all industrial areas.

CRANE CO.

VALVES · FITTINGS · PIPE
KITCHENS · PLUMBING · HEATING

THRIFTY BUYER

CRANE'S FIRST CENTURY...1855-1955

UNITS LIKE THESE...

BRING SAVINGS LIKE THESE...

- **In a New York skyscraper, Dorex Air Recovery eliminated the need for two large ducts up through 39 floors—saving valuable space as well as installation costs.**
- **In a Pittsburgh building, Dorex Air Recovery cut required air intake in half—saving some $47,000 on original equipment.**
- **In Chicago, a large industrial plant found Dorex Air Recovery so reduced required boiler capacity that over $40,000 was saved.**

BEST WAY to build your air conditioning and ventilating reputation is to offer a better installation that will save your customers money. You can do this by making Dorex Air Recovery part of your systems. The savings shown above are typical.

Dorex Air Recovery utilizes activated carbon to "manufacture" fresh air. Thus, intake of outside air can be reduced by as much as two-thirds—with corresponding savings in heating and cooling capacity.

Let us show you how Dorex can help improve your air conditioning and ventilating layouts. Write today for complete information. No obligation, of course. Connor Engineering Corp., Dept. A-85, Danbury, Conn.

CONNOR

dorex®

air recovery

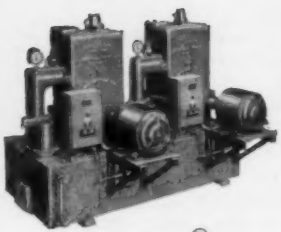
You Really Have to Listen to Hear CHICAGO HEATING PUMPS

Quality Makes Them Quiet

In a heating pump, silence—or near silence is golden. It tells you, first of all, that here is a precision-made pump that will "pay off" through years of service . . . with least maintenance and continuous high performance. And quiet operation of a heating pump means quieter operation of the entire heating system.

A Size for Every Job

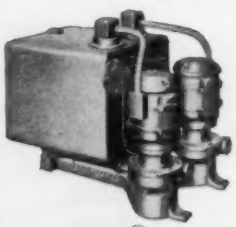
There are Chicago Heating Pumps for every type of heating job. This means you can get a Chicago Pump that exactly fits your requirements — in capacity, pressure, and equivalent direction radiation ratings. You don't have to accept a substitute that may labor at heavy loads and then need excessive maintenance to keep it in service. Specify Chicago Pumps and be sure of quiet, efficient pumping — always. Write to Department C for descriptive literature.



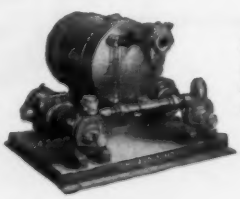
Type AVC condensation pump & receiver for 5,000 to 10,000 EDR and 10 to 30 psi. Write for Bulletin 245.

Duplex Condo-Vac® return line vacuum and boiler feed pump for vacuum systems at pressures to 40 psi, 2,500 to 150,000 EDR. Described in Bulletin 270.

Type CLL1 vertical condensation pump & receiver for low returns. 1,000 to 40,000 EDR and 10 to 52 psi. Bulletin 255.



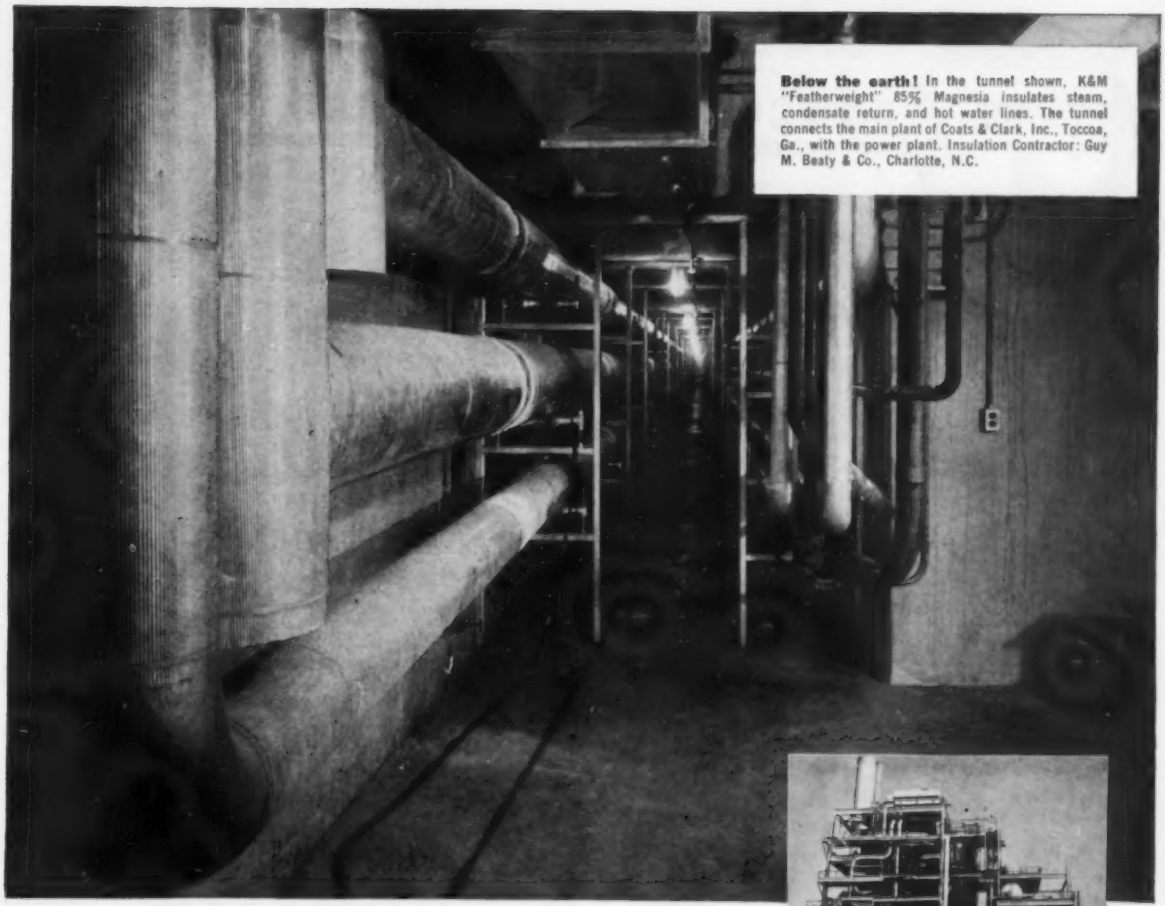
Sure Return® condensation pump and receiver. Will not steam bind. For low and medium pressure systems to 75,000 EDR. Described in Bulletin 250.



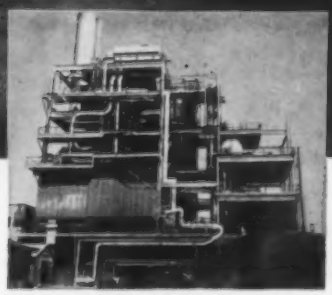
Duplex FC condensation unit for capacities up to 50,000 EDR and 150 psi. Described in Bulletin 260.

CHICAGO PUMP COMPANY
Subsidiary of Food Machinery and Chemical Corporation
BUILDING PUMP DIVISION
622 DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

Condo-Vac®, Sure Return®, AVC, LVC, Fire, House & Circulating Pumps, Pneumatic & Tankless Water Systems, Flush Kleen® Sewage Ejectors, Little Giant® & Non-Clog Bilge Pumps. Pumps for every industrial use.



Below the earth! In the tunnel shown, K&M "Featherweight" 85% Magnesia insulates steam, condensate return, and hot water lines. The tunnel connects the main plant of Coats & Clark, Inc., Toccoa, Ga., with the power plant. Insulation Contractor: Guy M. Beaty & Co., Charlotte, N.C.



Above the earth! At the Oklahoma Gas and Electric Company's plant in Sulphur, Oklahoma, K&M "Featherweight" 85% Magnesia insulates equipment exposed to the elements.

Underground or far aloft— K&M high pressure insulations save dollars by saving heat!

Wherever they're used, K&M insulations give efficient, heat-saving service. K&M "Featherweight"® 85% Magnesia—used on the steam lines in the tunnel shown above—lasts the life of the equipment it serves. It withstands moisture, vibration, and frequent temperature changes. Supplied in various sizes and thicknesses, it's frequently used in combination with another outstanding Keasbey & Mattison high pressure insulation—K&M Hy-Temp.

These materials, when used together, and applied so that joints are staggered, eliminate the heat loss that normally occurs in single-layer installations—particularly when expansion causes joints to open.

For efficiency to 1900°F. — K&M Hy-Temp Insulation. Usually applied in combination with K&M "Featherweight" 85% Magnesia. This material is made of diatomaceous silica combined with heat-resistant mineral fillers and asbestos fiber.

For efficiency to 600°F. — K & M "Featherweight" 85% Magnesia. 85% of this insulation is composed of basic carbonate of magnesia, the remainder of asbestos fiber.

Where severe water exposure may damage insulation, or where high humidity and moisture are present, K&M "Featherweight" Water-Resistant Magnesia is especially effective. It withstands temperatures to 450°F.

All K&M high pressure materials assure you dependable, economical insulation —be sure to keep them in mind! For additional data—and the name of your K&M distributor, who is also an experienced applicator—write directly to us.

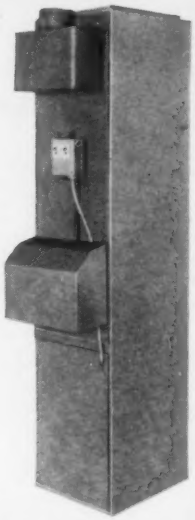
KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos®

JOHN ZINK JZ

- NEW -
FORCED-AIR GAS-FIRED HEATERS

A GOOD BRAND



CONVENTIONAL FLOW UNITS

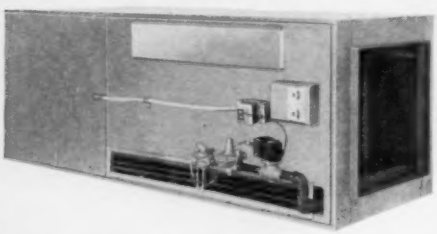
Two sizes HBD-70 Input rating 70,000 Btu., HBD-85 Input rating 85,000 Btu. Have return air inlet at bottom of unit, warm air outlet at the top.

All Heaters are equipped with "Whisper-Quiet" rubber mounted direct drive blower.

Compactly designed for minimum floor space.

All heaters are equipped with fully automatic controls. Each heater is shipped ready for installation, no expensive on-the-job assembly required.

All heaters are A.G.A. Approved for operation with natural, mixed, manufactured and LP gases.



ATTIC TYPE AFS-110, Input 110,000 Btu.

Side flue outlet requires no additional height for diverter installation

Space requirements kept to absolute minimum.

Attractive grey-green hammer finish.

DOWN FLOW UNIT

CFD-85, Input 85,000 Btu. Has return air inlet at top, and warm air outlet at bottom suitable for perimeter heating.

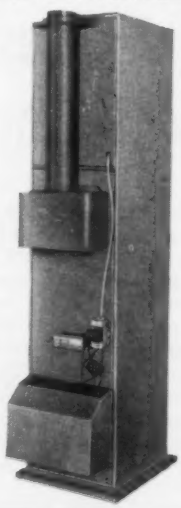
Equipped with permanent type filters.

Built-in draft diverters provide easier installation. Control panel is enclosed by very attractive cover. Controls, blower and burner are all easily accessible. Rugged cast iron burners are slotted for long life and trouble free operation.

Outside casings of heaters are hand-cool, highest quality insulation keeps heat in the heater. Every bit of heat is extracted from the fuel — value received from gas burned.

All heaters are rigidly inspected and individually tested at the factory before shipment.

All heaters are A.G.A. Approved for operation with natural, mixed, manufactured and LP gases.



Write for complete descriptions and specifications.

JOHN ZINK COMPANY

4401 South Peoria — Tulsa, Oklahoma

Random Thoughts from a Filter Engineer

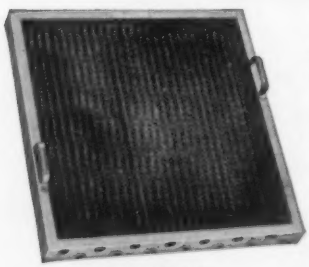
by J. P. Van Sweringen

- **SHOULD GREASE FILTERS OPERATE AT HIGH OR LOW VELOCITY?**
- **WHERE VENTILATING FILTERS SHOULD NOT BE USED**
- **THAT SOMETHING INVISIBLE THAT COMES WITH EVERY FILTER**

SHOULD GREASE FILTERS OPERATE AT HIGH OR LOW VELOCITY?

When it comes to planning a grease filter installation, you have two types of filters to choose from: the high-velocity and the low-velocity filter. Because you need fewer high-velocity filters for a given installation, some contractors and engineers feel that the saving in initial filter cost makes them the best bet. On the other hand, because high-velocity panels filter more air per filter, they fill up with grease faster. Naturally, they require servicing at more frequent intervals. As a result, many contractors and engineers feel that the low-velocity filter offers greater savings in the long run.

At Air-Maze, we make both types so we have no particular axe to grind. However, it's our honest opinion that the long-term maintenance savings from low-velocity filters more than make up for the higher initial cost of more filters per installation. Our low-velocity filter is the Greastop and we feel it has extra features that make it the finest of its kind. For instance, the fine mesh screen in the Greastop is especially protected against corrosion from the fatty acids in grease. And the progressive density of the media permits the collection of lots of lint and bulky material without unduly reducing the air flow. It's another Air-Maze extra value.



Greastop® filter.

WHERE VENTILATING FILTERS SHOULD NOT BE USED

With all the types of ventilating filters available on the market, it's easy to see how a person might believe that a ventilating filter—*some* ventilating filter—will solve almost any air filtering problem. This is not true. There are many jobs ventilating filters just can't do well. For instance, a ventilating filter falls down where dust concentration is very high, as in the case of filtering exhaust air in certain manufacturing processes.

A viscous impingement filter is unsatisfactory because the adhesive doesn't have time to "wet" the dirt particles enough so that they'll be properly filtered. And a dry or strainer type filter won't do the job either. It will stop the dust well enough but filter resistance rises too rapidly for it to be practical.

Usually, ventilating filters are not indicated when there's a dirt concentration of more than 6 grains per thousand cubic feet. And much less than this is desirable. To give you an idea of how quickly the dirt-holding capacity of a filter can be reached; at a concentration of 6 grains per thousand cubic feet, a 20 x 20 panel may be subjected to almost a pound and a half of dirt per day!

THAT SOMETHING INVISIBLE THAT COMES WITH EVERY FILTER

When you buy a product—be it a small filter or a large generator—you usually take for granted the service that comes along with it. Product features often obscure service to the extent that it isn't even mentioned before the sale is made. Yet service is the great unseen part of a product . . . the part that guarantees that the product performs at its best.

Map shows 83 Air-Maze representatives.

When you buy filters from Air-Maze, quick service is as near as your phone. Our trained representatives are located in 83 cities across the nation. They stand ready with friendly, competent help, whenever you need it. The Air-Maze Corp., 25000 Miles Rd., Cleveland 28, Ohio.

AFI MEMBER AIR FILTER INSTITUTE

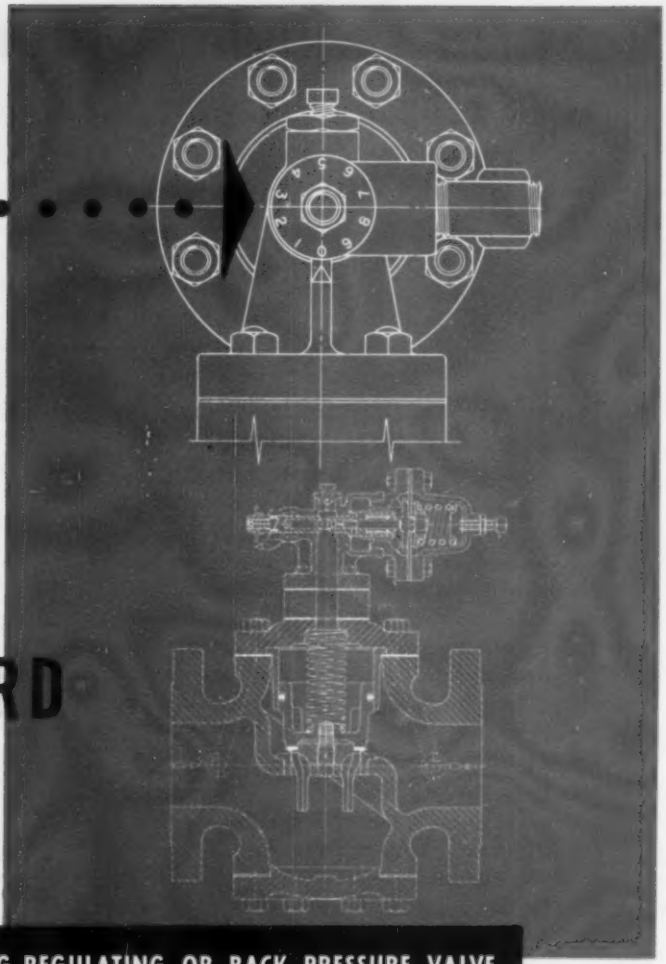
AIR-MAZE

The Filter Engineers

AIR FILTERS • SILENCERS • SPARK ARRESTERS
LIQUID FILTERS • OIL SEPARATORS • GREASE FILTERS

FOR EXCEPTIONAL CONTROL

a pilot-operated valve with adjustable throttling range



the NEW Improved

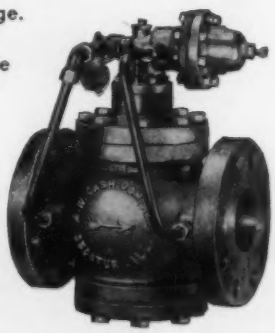
CASH STANDARD

TYPE 10 VALVE

- SELF-CONTAINED
- SINGLE SEAT— tight closure
- LARGE CAPACITY

SERVES AS PRESSURE REDUCING-REGULATING OR BACK PRESSURE VALVE

- Improved Y-type strainer in pilot control line protects pilot.
- Simple dial-type range selector permits selection of throttling range required for the most stable and sensitive control.
- Switching control piping easily converts valve from pressure reducing to back pressure operation.
- Diaphragm assembly easily changed to convert to different pressure range.
- Packless design results in low friction and high sensitivity.
- Recommended for: water systems, altitude control, as an unloading valve on extrusion presses, back pressure control, oil refineries.
- For use with water, gas, air, light oils, refrigerants (ammonia, freon).
- Materials: iron, bronze or steel body; bronze or stainless steel trim; monel trim on pilot valve. Composition or metal seat.
- Sizes: 2" to 3" with screwed ends.
  2" to 12" with flanged ends.



WRITE TODAY FOR COMPLETE INFORMATION AND LITERATURE

CASH STANDARD

A. W. CASH COMPANY • P.O. BOX 551, DECATUR, ILL.

PRESSURE, HYDRAULIC, TEMPERATURE, PROCESS AND COMBUSTION CONTROLS

When Selecting Ceiling Air Diffusers . . .

AIR-FACTORS, Inc., "DIFFUSER SELECTION SYSTEM" will . . .

Rate of Total Room Air Motion Designed to:

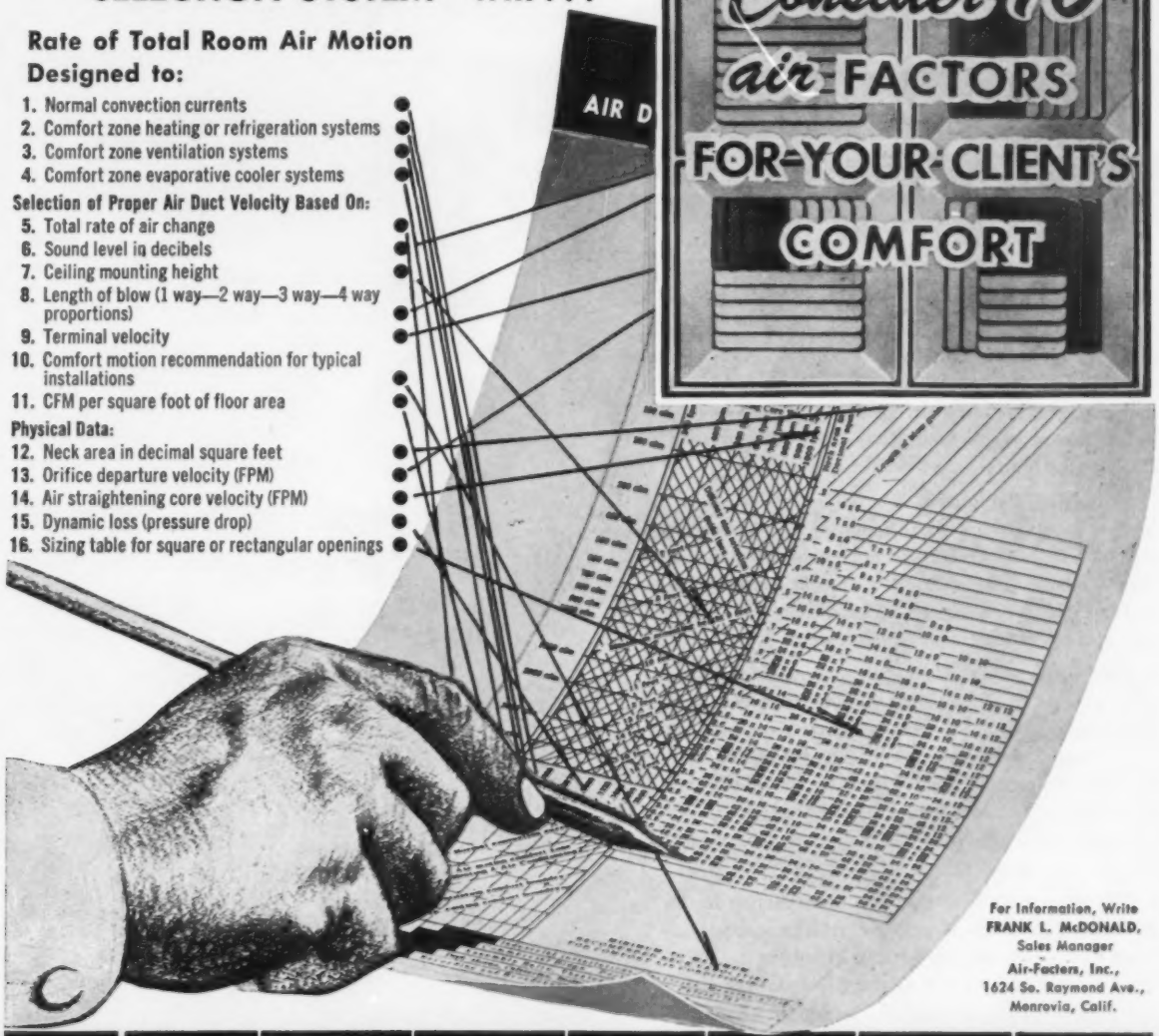
1. Normal convection currents
2. Comfort zone heating or refrigeration systems
3. Comfort zone ventilation systems
4. Comfort zone evaporative cooler systems

Selection of Proper Air Duct Velocity Based On:

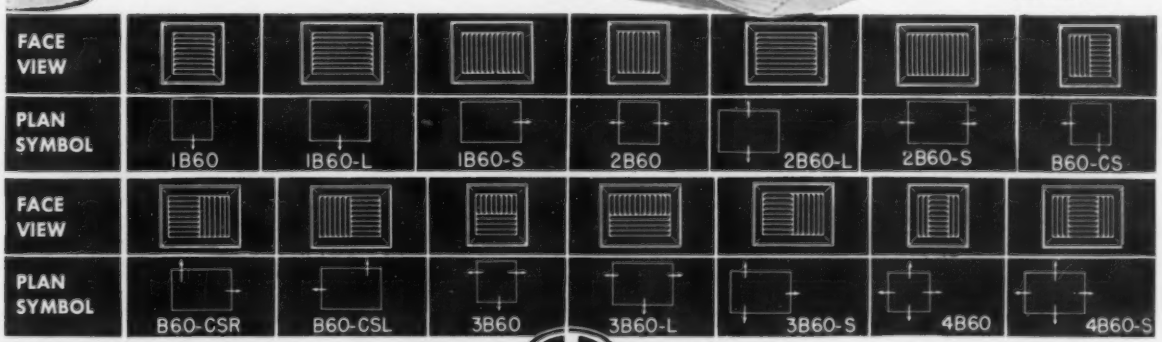
5. Total rate of air change
6. Sound level in decibels
7. Ceiling mounting height
8. Length of blow (1 way—2 way—3 way—4 way proportions)
9. Terminal velocity
10. Comfort motion recommendation for typical installations
11. CFM per square foot of floor area

Physical Data:

12. Neck area in decimal square feet
13. Orifice departure velocity (FPM)
14. Air straightening core velocity (FPM)
15. Dynamic loss (pressure drop)
16. Sizing table for square or rectangular openings



For Information, Write
FRANK L. McDONALD,
Sales Manager
Air-Factors, Inc.,
1624 So. Raymond Ave.,
Monrovia, Calif.



AIR DISTRIBUTION
AIR CONTROL

AIR-FACTORS INC

MONROVIA
CALIFORNIA

American-Standard announces

the new Horizontal Remotaire

...provides economical heating-cooling

...makes best use of available space

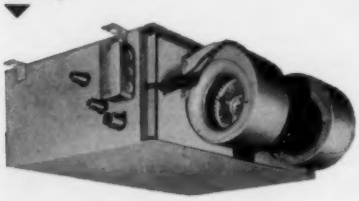
• You can hang Horizontal Remotaire Units on the ceiling—between rooms, in closets, above false ceilings. Similar to the famous Remotaire floor models, these compact horizontal units heat, cool, filter and recirculate *all* the room air. Three models solve every installation problem. Four sizes—200, 300, 400 and 600 cfm capacities—meet every room need.

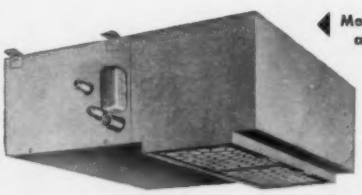
Horizontal Remotaires are only 8½" to 10¾" high . . . require minimum headroom for reduced installation costs. These units are equipped with extended winding motors for low current consumption and have sealed-in oil supply for dependable operation and absolute minimum maintenance.

Like all Remotaire units, this new model operates with heated or chilled water supplied from a central plant through a simple, compact piping system. The new Horizontal Remotaire unit can readily be used in new construction and is especially suitable for remodeling. It allows you to install the unit in almost any available space, and often permits the use of your original piping system.

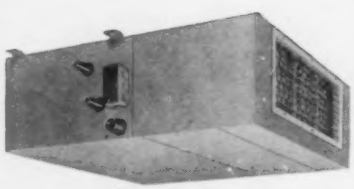
For more information on this new addition to the complete line of American-Standard Remotaire Heating-Cooling Systems, just write to Plumbing and Heating Division, American Radiator & Standard Sanitary Corporation, P. O. Box 1226, Pittsburgh 30, Pa.

Model H—ideal for use in a hallway.





◀ Model HB—especially suitable for closet installation.



▲ Model HR—best to use free-hanging from a ceiling . . . can be concealed.

AMERICAN-Standard

WATER HEATING-COOLING SYSTEMS

Question-Mark* FITTINGS

. . . A BARGAIN?

They could cost you your reputation!

***QUESTION-MARK FITTINGS**

Who is manufacturer?
How about his reputation?
What is his experience?
Does he give service?
Does he offer complete line?
Is stock available nearby?
Do fittings meet U. S. standards?
Are dimensions accurate?
Is circularity true?
Equal to strength of pipe?
Are fittings permanently marked with manufacturer's trademark and material designation?

YOU RUN THESE RISKS WITH THESE UNKNOWN PRODUCTS:

Failure in service . . . work stoppage . . . waste.
Impaired efficiency due to improper design.
Non-uniformity . . . wastes manhours.
Poor availability . . . costly in emergencies.
Short-line supply . . . handicaps selection.
Lack of service or responsibility.
Lack of engineering help on piping problems.
Lack of cost-cutting advancements.

Presented in the interests of piping safety and economy by

TUBE TURNS

A Division of National Cylinder Gas Company
LOUISVILLE 1, KENTUCKY

. . . Producer of **KNOWN VALUES**

Remember the trade-marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS.

How to safeguard your piping and get *more for your money*

When you buy TUBE-TURN* Welding Fittings and Flanges, you get these known values:

TOP QUALITY AND SAFETY RESPONSIBILITY PRECISE UNIFORMITY
ENGINEERING SERVICE WIDE SELECTION LOWEST-COST PERFORMANCE
PROMPT DELIVERY DESIGN ADVANCEMENTS

They are made in U.S.A. and are identified by the trade marks shown above.

They meet ALL American Standard and Safety Code requirements.

They are engineered to give maximum strength and performance and in many cases exceed requirements by generous margins.

To get *more for your money* in welding fittings and flanges, specify the leading brand and buy from your trusted Tube Turns' Distributor.

Tube Turns' nearby complete stock SAVES YOUR PURCHASING TIME

Tube Turns' pioneering research GIVES YOU ADVANCED PRODUCTS

Tube Turns' engineering help GIVES YOU COST-CUTTING IDEAS

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS

LOUISVILLE 1, KENTUCKY

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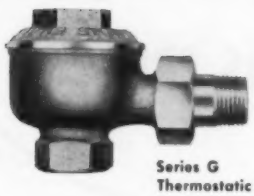
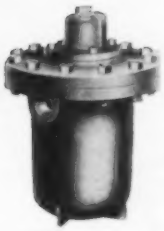


Series G
Thermostatic Trap

Standard Pressure Range
15 pounds to 25 inches
vacuum

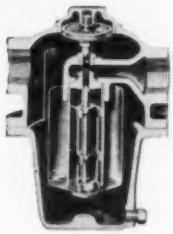


Series 45
Steam Trap

For pressures
between 400 and
600 lbs. Body and
Cover of special steel

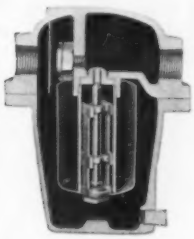
from 25" vacuum to 600 lb. pressure

illinois STEAM TRAPS



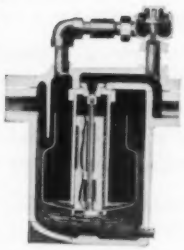
Series G Float
and Thermostatic
Trap

Standard Pressure
Range 15 pounds to
25 inches vacuum



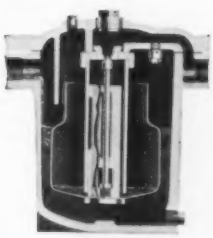
Number 30
Steam Trap

For Pressures up
to 150 pounds



Series 36
Steam Trap

For pressures
up to 30 pounds



Series 35
Steam Trap

For pressures
up to 250 pounds

Prevent Steam Waste—Save Fuel

No matter what your condensate drainage problem may be—for low, medium or high pressure steam or compressed air service—there is an Illinois Trap exactly suited to do the job efficiently, economically. You have a wide variety of types and sizes from which to choose. Before your next trap purchase investigate Illinois with its outstanding record for preventing steam waste and saving fuel. The Illinois representative nearest you will furnish facts and figures—or write for bulletins.

1900 55 1955 YEARS
illinois ENGINEERING
A DIVISION OF AMERICAN AIR FILTER, INC.

illinois ENGINEERING

ILLINOIS ENGINEERING COMPANY
DIVISION OF AMERICAN AIR FILTER COMPANY, INC.
2035 SOUTH RACINE AVENUE • CHICAGO 8, ILLINOIS

WHO SAID AIR IS FREE?

Were it not for Radiation and Convection, empty air spaces inside walls, roofs, etc. would be the best insulation. But why pay costly labor and storage bills for handling "free" air entrapped **before** it is used in bulky insulation? Bulky materials also require more freight cars, trailers and trucks. The "free" air is paid for over and over again.

Multiple accordion aluminum envelops large volumes of air and creates layers of air spaces **only** as it is opened when finally stapled in place. This air is **really** free.

Multiple accordion aluminum as it comes compactly from package contains very little air.
As installed creates multiple layers of "free" air.

COST OF EDGE-TO-EDGE INFRA
Multiple Aluminum Insulation installed in new construction between wood joists, material and labor
Type 6-PS about 10¢ sq. ft.
Type 4-PS about 8¢ sq. ft.

With respect to radiant heat flow, the aluminum sheets have 97% reflectivity, and 3% absorptivity and emissivity. Low conduction results from the preponderant air spaces of low density. The layers of multiple aluminum and fiber retard inner and outer convection. The tough aluminum sheets are almost impervious to vapor flow. Infiltration under flat stapled flanges is slight. Condensation formation on or within is minimized by the scientific construction of multiple layers of joist-to-joist, full-depth* accordion aluminum, fiber, and air spaces. *Patent applied for.

MILLION SQ. FT. IN ROOM 12′ x 13′ x 13′

Because of the low volume of unopened, practically airless multiple aluminum, an ordinary passenger auto will easily hold 20,000 sq. ft. A railroad freight car, a huge interstate trailer, or a number of trucks would be needed to transport an equivalent amount of ordinary insulation.

The American Society of Heating & Air-Conditioning Engineers has published a booklet which describes convection, conduction, and radiation heat flow through *ordinary* air spaces, and what happens when an ordinary building space is lined or subdivided by reflective metals, thus creating reflective air spaces. Ask us for a copy—it's free.

INFRA INSULATION, INC.
525 Broadway, New York, N. Y., Dept. (H-8)

☐ Please send ASHAE booklet "Insulating Effect of Successive Air Spaces Bounded by Bright Metallic Surfaces."

☐ Please send samples.

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THE EDITORS' PAGES

• *HUMAN ENGINEERING, already proposed as a separate branch of engineering, continues to receive increased attention on two main fronts, medical and engineering. One of the latest tools to be applied for maximum productivity without imposing undue stress upon the worker is air conditioning. Where it is impractical to condition an entire plant — because of high temperature processes, for example — frequent rest periods in air conditioned rooms are being found profitable in several plants. For the story of continuing experiments along this line, see page 92 in this issue.*

Church Construction To Cost $6 Billion

. . . In next 10 years

Construction and remodeling of 70,000 churches and synagogues in the U. S. in the next 10 years will cost nearly $6 billion, estimates George Cline Smith, economist of F. W. Dodge Corp., writing in a recent issue of Architectural Record.

In addition, 12,500 parish houses, Sunday school buildings, and related buildings will cost $1¼ billion, he estimates. Parochial school buildings are not included.

The prediction is based on the assumptions that there will be no severe depression, no major war, and no major change in the value of the dollar.

Contract awards for religious buildings in the 37 states east of the Rockies during the first quarter of 1955 totaled $128 million. This is an increase of 60 percent above the previous first-quarter record in 1951, and 61 percent above last year, Mr. Smith says.

The religious category in the first quarter of 1955 accounted for about 7 percent of all non-residential building awards, he says.

Construction Awards 30 Percent Higher

. . . than last year

FUTURE CONSTRUCTION contract awards in the 37 states east of the Rockies continue to set new records. The latest figure, for June, is a grand total of $2,255,209,000, up 30 percent over June a year ago, according to the F. W. Dodge Corp. It is the highest June total ever recorded.

Construction awards for the first six months of the year, up 30 percent over the same period last year, totaled $11,982,771,000, setting a new high for a first half year.

Non-residential awards for June totaled $842,618,000, up 28 percent over June 1954; residential, $951,104,000, up 32 percent; and heavy engineering, $461,487,000, up 29 percent.

At the end of the first half, non-residential awards reached $4,132,513,000, 21 percent ahead of the 1954 period; residential, $5,456,730,000, up 37 percent; and heavy engineering, $2,393,528,000, up 29 percent.

Hard Coal Sales Equal To Those of Last Year

. . . equipment sales up 40 percent

IN CONTRAST to the downward trend of recent years, hard coal sales are substantially equal to those of last

Sees Big Future for Snow Melting

. . . Many applications for varied uses

SAMUEL H. NITZBERG took time off from activities of the big Shrine convention in Chicago last month to discuss snow melting and radiant heating developments with R. W. Roose, HPAC's editor

A "GREAT POTENTIAL" and many additional applications for snow melting piping systems are forecast by Samuel H. Nitzberg, president of the Atlantic Pipe Bending & Fabricating Corp. He visited HPAC's offices last month during the big Shrine convention in Chicago.

He believes that one of snow melting's most important uses will be the heating of military and civilian airport runways to keep them in service despite the weather. He feels that the cost of installation and operation of the snow melting equipment, when balanced against the tremendous investment and importance of an airport, may well be justified in order to keep it in use in all weather.

Another desirable application is a heated parking slab for storing diesel buses overnight outdoors. With a heated slab, snow, ice, and salt accumulations are melted off, protecting the bus and facilitating its servicing. Starting in the morning is improved, too.

A similar use of snow melting is a heated outdoor layout slab for pipe bending and fabricating work that Mr. Nitzberg plans to use at his new plant.

And he sees the possibility sometime in the future of entire snow melted highways — such as one from the States to Alaska, for example.

It is important, Mr. Nitzberg believes, to make careful provisions to protect big snow melting and radiant heating installations against electrolytic corrosion. He recommends that a polyethylene membrane be used under the slab where there is a ground water condition which would promote corrosion of the piping in the slab. In one case, piping in one corner of a slab failed; the trouble was traced to two dry wells at the location which flooded during rainstorms.

Heat transfer oil is being used as the heating medium on a number of snow melting installations for large airplane hangar doors, he reported.

year, according to the Anthracite Institute.

Sales of 15,864,000 tons for the seven month period ending May 31, 1955, were less than 1/3 of 1 percent less than for the same 1953-1954 period.

The current figures are coupled with an amazing 40 percent rise in automatic equipment sales during the same period.

Air Conditioning Jobs Seen Doubled By 1960

. . . in line with doubled output

AIR CONDITIONING will create 400,000 new jobs in the U.S. by 1960, according to George S. Jones, Jr., managing director of the Air-Conditioning and Refrigeration Institute.

This prediction is based on estimates that the air conditioning industry will double its output in the next five years. The industry currently employs over 400,000 people, Mr. Jones points out.

Needed are engineers, scientists, researchers, production technicians, and marketing experts, he says.

35 Percent of All Chain Stores Air Conditioned

. . . installations hit peak in 1954

CHAIN STORES spent more for air conditioning installations last year than any year before, according to a survey in Chain Store Age. The survey covered 1059 companies operating 27,686 stores.

The 1954 expenditure was $54 million, 10 percent above the previous peak in 1953.

More than 7600 chain stores were air conditioned in 1954.

About 35 percent of all chain stores — companies operating two stores or more — are air conditioned. Many chains accept air conditioning as a merchandising necessity.

From 1949 through 1954, more than $266 million was spent for air conditioning installations by the chains.

Percentages of air conditioned chain stores in several fields are as follows:

Grocery-supermarket	29
Variety-general merchandise	49
Drug	75
Apparel	62
Shoe	66
Restaurant	77
Auto supply-hardware	14
All other	9

Expenditures for air conditioning installations made by landlords for their chain store tenants are not included in the survey. These would undoubtedly raise the total for 1954 to above $65 million.

Is Air Conditioning Cost Changing Building Design

. . . toward smaller windows?

SMALLER GLASS AREAS, in place of "window-walls," may be in store for office buildings of the future, as a result of the cost of air conditioning, according to architect Henry Wright. Mr. Wright, a technical consultant to building materials manufacturers, who made a study of the problem, points out that an additional ton of air conditioning is needed, at a cost of $300 to $800, for every 100 sq ft of unshaded, unfavorably oriented glass in a tall building in most of the U.S.

"This arithmetic is producing some hard new thinking about office building walls, and even the shape of such buildings," he declares.

The impact of air conditioning on large building design was discussed by Mr. Wright in an article in Architectural Forum.

Acetylene Cylinders Should Be Kept Upright

. . . for best welding results

ACETYLENE CYLINDERS should be stored and used in an upright position for best results in welding, according to the Linde Air Products Co. Under pressure, acetylene gas is dissolved in liquid acetone, which saturates a solid, absorbent filler. When the cylinder valve is opened, the pressure is relieved, and the acetylene comes out of the acetone as a gas, ready for use.

If a cylinder is used while lying on its side, the liquid acetone may get into the regulator and prevent it from working properly. If the acetone reaches the blowpipe tip, it will greatly reduce the flame temperature. When this happens, a sound weld is difficult to make.

Room Air Conditioner Sales Breaking Record

. . . up 30 percent

SALES OF room air conditioners during the first quarter of 1955 increased 30 percent over the same period of last year, according to the Air-Conditioning and Refrigeration Institute.

At the same time, inventories at the wholesale and factory levels are down nearly 12 percent indicating a rapid liquidation of last year's carry-over.

These figures, for what usually are the three worst air conditioner sales months, indicate another record year for the industry.

About one million units were installed last year, which represented the largest number of sales in the history of the industry. Industry spokesmen earlier had predicted an increase in sales of about 20 percent for 1955. The large first quarter volume may require raising the figure by 10 percent or more.

"Quote"

"Engineers are frequently wrong but never in doubt."—*Dr. A. M. Zarem, of the Stanford Research Institute, at the semi-annual banquet of the American Society of Heating and Air-Conditioning Engineers, in San Francisco.*

"a lady likes her hot bath **Rust-Free"**

a p-k cement-lined water heater supplies it economically for Elsie

Rust-free hot water is essential for dairy cleaning operations and the Borden Ice Cream Plant in Wilmington, Delaware, gets an abundance of it from a **p-k** cement-lined hot water storage heater.

This 1200 gal. capacity unit provides hot water for the nightly washdown of all the dairy's process equipment. It heats 5400 gph from 40 deg. F. to 180 deg. F., using steam at 100-lb. pressure.

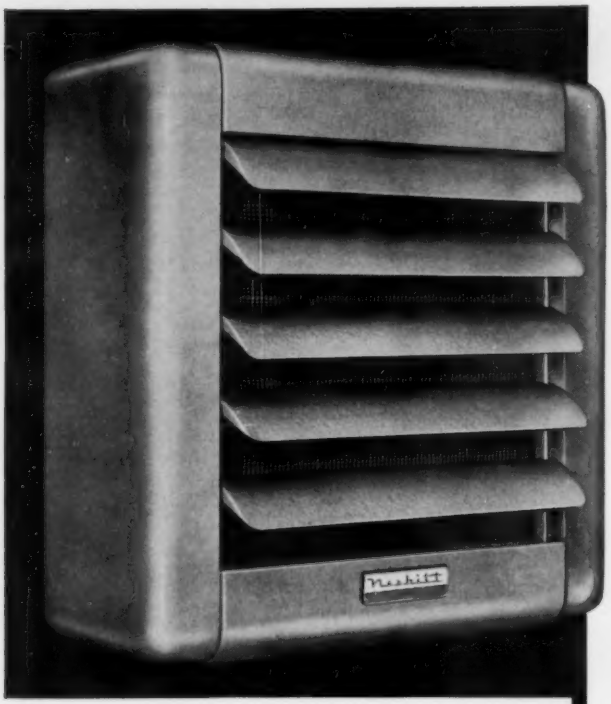
The **p-k** heater is cement-lined to provide clean water for long life and low cost. A cement lining is applied over a tough metal lath welded to a carbon steel shell. Fortifying the outer steel shell against corrosion, it assures an ample supply of rust-free hot water. The heater meets all ASME specifications.

When you need standby hot water for intermittent demand in capacities from 180 to 10,000 gal., a **p-k** cement-lined hot water storage heater is an excellent investment.

Write for your copy of the **p-k** *Hot Water Heater Bulletin.*

the **Patterson-Kelley Co.,** inc.
780 Burson Street, East Stroudsburg, Penn.

101 Park Avenue, New York 17 • Railway Exchange Building, Chicago 4 • 1700 Walnut Street, Philadelphia 3 • 96-A Huntington Avenue, Boston 16 • and other principal cities



new

propeller-fan unit heaters for steam or hot water . . . without sacrificing capacity

The first unit heaters rated under new Sound Measurement Test Code of IUHA

NESBITTS wholly new propeller-fan unit heaters are the first in the field to be tested by the Sound Measurement Test Code adopted this year by the Industrial Unit Heater Association. All units rated within the four lowest sound classifications! Now you can select models with sound emission accurately classified by type of installation—assuring you the most quiet unit for the capacity required.

That's only part of the story. Nesbitt universal heating elements of flat plate-type fins and U-bend coil construction can be used with either steam or hot water (on high temperature drops) *without sacrificing capacity*. Half as many models meet all your needs. Cuts inventory and selection problems in half! Use of low water rates and high temperature drops permits further labor and material savings on hot water installations.

This new Nesbitt line offers an unusual combination of values in construction, performance, appearance and cost. Send for Publication 401.

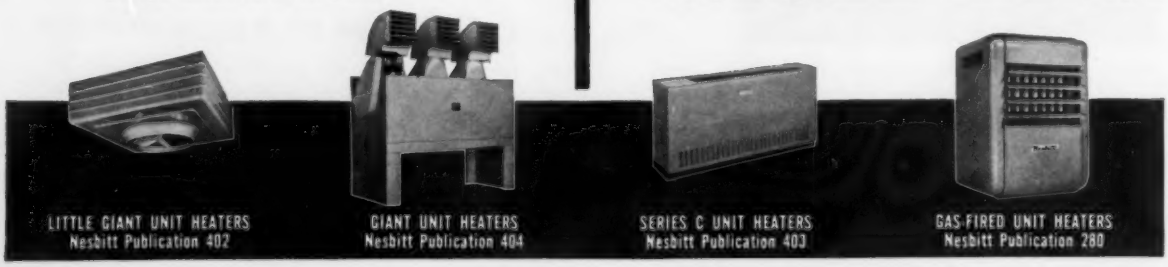
plus all these special features:

- Eight basic unit sizes, 24 models ranging from 15,000 to 335,000 Btu per hour.
- Universal heating elements give maximum performance on either steam or hot water systems.
- U-bend coil construction permits high water capacities and temperature drops.
- Low water rates effect time and material savings in piping and installation.
- Minimum air-flow resistance reduces noise level, lowers operating and maintenance costs.
- Seamless copper condensing tubes and bends; corrugated aluminum fins mechanically bonded.
- Male piping connections extending through casing rear simplify installation and save headroom.
- Accurately balanced aluminum fans for quiet, efficient, large-volume air delivery.
- Rugged, heavy gauge die-formed steel casings are smartly styled for modern interiors.
- Deep drawn air intake opening in rear of casing assures maximum fan performance.
- Easily adjustable discharge louvers; available also with double deflection louvers.
- Attractive green metallic hammered finish is baked on phosphatized steel for long life.

Nesbitt

THE NAME TO GO BUY IN UNIT HEATERS

Made by John J. Nesbitt, Inc., Philadelphia 36, Pa.
Sold by Leading Wholesalers — Information on Request



LITTLE GIANT UNIT HEATERS
Nesbitt Publication 402

GIANT UNIT HEATERS
Nesbitt Publication 404

SERIES C UNIT HEATERS
Nesbitt Publication 403

GAS-FIRED UNIT HEATERS
Nesbitt Publication 280

"OPEN FOR DISCUSSION"

• *WE FOLLOW HERE each month the practice at engineering society meetings of providing an "open for discussion" period. You are urged to take part. Just address your comments to the Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave, Chicago 2.*

Church Air Conditioning Article Whimsical But Thought Provoking

THE ARTICLE, *A Minister Tells Why Air Conditioning for Churches Is Necessary*, by Morgan M. Miles, in the July HPAC, is a whimsical but thought provoking statement of the many real difficulties which face churches today in many communities.

An experience of one of our clients several years ago pointed out the economic value of air conditioning a church. The problem became whether to abandon the existing plant and facilities — which were entirely adequate and satisfactory in many respects, except for traffic noises on the adjoining street — or to provide the necessary acoustical barriers that would prevent the entrance of outside noises, and air condition the building.

Only a small portion of the investment could be realized if the existing property were sold. In addition, new facilities constructed in a neighborhood where street noises would not be a problem would cost a great deal more than the existing plant because of the greatly increased cost of construction in recent years.

There was no question that the economical solution was to provide the necessary sound barriers and to air condition the sanctuary.

In designing the sound barriers, the architects consulted with a recognized authority on acoustical problems and produced a finished job, which has been most happily satisfactory to all.

As usual, other benefits from air conditioning have been realized. The cleaning problem has been reduced, the comfort of the occupants has been greatly increased, and the money saved over that which would have had to be spent on new facilities has been used to further increase and improve the existing facilities.

I. A. NAMAN
Consulting Engineer

Use Ceiling Insulation, Air Space for Cool Church on a Warm Day

IN HIS ARTICLE, *A Minister Tells Why Air Conditioning for Churches Is Necessary*, in the July HPAC, Morgan M. Miles has expressed elegantly the feelings of the Cloth concerning hot Sabbath services. Many church auditoriums follow the Gothic pattern and have high roofs supported by exposed trusses. The roof surface generally is black and may be entirely innocent of insulation.

For many years every new school building in a large city in the southern U. S. was given an attic. The reason for this was that the attic air could acquire a large share in the heat from the sun, and thus reduce the temperature of the air in the classrooms on the top story.

The next church that I help build will receive my heartfelt advice about an intermediate air space between the auditorium ceiling and the roof. I would advertise the church by using an aluminum top or at least a reflective surface like the shiny dome of a farmer's silo. I would have several inches of fireproof, non-organic, insulation under the roof surface. I would discourage the provision of windows. If opened, windows admit noise and dust and insects. And they do not compare in efficiency with electric lamps. We can control illumination by electric switches far more satisfactorily than by trusting the sun and the clouds.

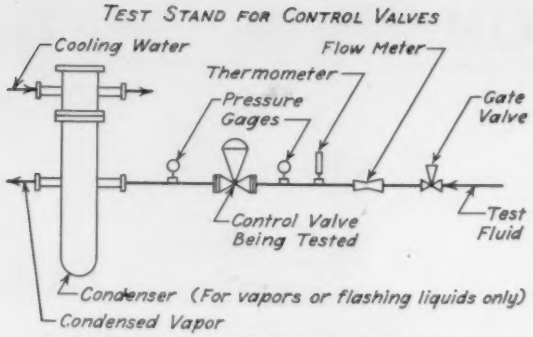
Colored glass memorials on the walls of a church may be tolerated, but they should not be used to keep out the rain. They may be truthful works of art placed against walls that resist heat transfer, and they may be illuminated by electricity far more effectively than by the sun.

Of course the church should have mechanical ventilation. The auditorium that I suggest can be cooled easily on any warm day.

SAMUEL R. LEWIS
Samuel R. Lewis and Associates
Consulting Mechanical Engineers

Inspect Valves Monthly in Some Cases; Replace Diaphragms Once a Year

THE QUESTION, *What's the Basis of a Maintenance Program for Valves?*, and the answers that have been given in the February, March, and June HPACs, have all been interesting. S. L. Hanauer asked for a basis for inspection, overhaul and replacement of 30 diaphragm operated 1 in. pressure reducing valves for cold water service. Two specific points are raised: (1) How often should the valves be opened for inspection? (2) How often is it necessary to replace the diaphragm and other working parts?



TEST STAND for testing control valve's flow control accuracy and seat tightness includes: pressure gages upstream and downstream for seat tightness testing; a flow meter, thermometer and gages for checking flow control accuracy; and a condenser if the fluid is a vapor or flashing mixture

Erosion and corrosion are important criteria for establishing frequency of inspection. Although cold water is the given fluid stated, any possibility of handling a hot liquid should be given serious consideration, since flashing will result when the pressure is reduced across the valve. Flashing mixtures will lead to erosion of valve internals, which can be overcome by use of alloy steel trim such as 18-8 stainless or monel, inconel, etc. Monthly inspection is recommended for erosive and corrosive liquids.

Regardless of apparent condition, replacement of diaphragms should be made at least every year. Any part such as the seat, seat rings, stem, spring and packing glands showing wear should also be replaced. Recommended procedure requires the control valve be isolated from the piping system. Such an arrangement has block valves located upstream and downstream of the control valve and a manually operated bypass globe valve to permit isolating or removing the control valve without interrupting service. A few spare control valves in stock will permit replacement without making recourse to using a manually operated globe valve. This latter arrangement is desirable when precise or modulating control is required.

After thorough inspection and replacement of all worn parts, the control valve should be tested for flow control accuracy and seat tightness. The attached sketch is an elementary diagram for a control valve test stand that may be constructed at low cost. The required insruments for testing are pressure gages located upstream and downstream for valve seat tightness testing, a flow meter, thermometer and gages for checking flow control accuracy. If the fluid is a vapor or flashing mixture, a condenser should be employed as shown in the sketch.

Because of time and labor requirements, it is sometimes more economical to replace small control valves rather than renew parts.

H. B. WAYNE
Consulting Engineer

Predictions for 1995 Not Fantastic; Spread Facts of What We Have Today

I. W. COTTON'S ARTICLE, *Where Do We Go from Here in Heating and Air Conditioning?*, in the June HPAC, is very interesting, and I see no reason to quarrel with his convictions. Certainly there is no more fantasy — perhaps not quite as much — in his suggestions as to what to expect by 1995 as there would have been 40 years ago had the things we have today been predicted then. I can only say that I wish I would be here to find out.

However, while there is obviously room for improvement in the products and applications that we have today, the immediate and real problem, it seems to me, is making more people better acquainted with what we do have. We need, first, more and better-equipped men to tell the public what is available, to see to it that the proper product is properly sold and properly installed. We need to study more closely and become better informed as to the proper balance between construction details and equipment capacity and requirements.

We need more people to know better how to handle air distribution, or, perhaps I should say, how to get better and more uniform distribution of heat sources and of heat absorption. We also need better understanding of the problems of water usage.

Progress is being made, and I share with Mr. Cotton his enthusiastic prediction of things to come for us in the heating and air conditioning industry.

GEO. S. JONES, JR.
Managing Director
Air-Conditioning and Refrigeration Institute

Article on Heat Pump Installations Shows Trend To Accept Such Equipment

THE ARTICLE by W. D. Sinclair in the June HPAC, *How Much Does a Heat Pump System Cost?*, is further evidence of the solid trend toward the acceptance of such equipment.

Those of us who have had contact with the heat pump from the early years have always recognized the inherent advantages of the principle. The progress has, at times, been slow and even discouraging. Not only is summer cooling accepted today, but the demand is increasing.

With the demand for summer cooling, it seems logical to use the same basic equipment in winter for heating. Many people have attempted to justify the heat pump solely on the grounds of winter heating requirements. This is a most difficult, if not impossible, approach on economic grounds, in my opinion.

When installations take the pattern of larger cooling loads than heating loads, it is difficult to see how any rational selection of equipment can lead to any other decision than to use the heat pump.

T. BAUMEISTER
General Public Utilities Corp.

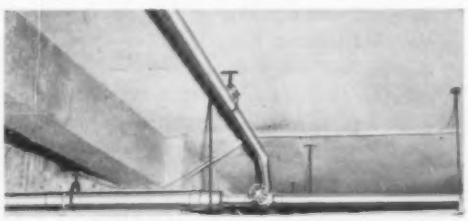
Architects: SHEPLEY, BULFINCH, RICHARDSON & ABBOTT and SMITH & SELLEW, Boston
Gen. Cont.: B. PERINI & SONS, Framingham, Mass.
Plumb. Cont.: C. H. CRONIN, Boston
Revere Dist.: CHARLES D. SHEEHY, INC., Boston

Boasting of ramps and half-flights of stairs, multi-unit construction for easy expandability and similar innovations, this $3,500,000 school is one of the most modern layouts in the country. Yet, its plumbing lines are being serviced by man's oldest metal . . . copper!

Although copper is man's oldest metal, it also is his newest. For it will help keep this school young as it has been keeping other buildings young for scores of centuries. Its enduring qualities outperform all other materials in water line service, while the many advantages of working with copper water tube, contractors tell us, make it easier, less costly, to install. There are fewer joints with Revere Copper Water Tube, and the joints that are necessary are made in a jiffy with fewer tools. They're tight, leak-free ones, too. And maintenance, a mighty important item in schools and similar buildings, is practically nil with non-rusting copper water tube on the job.

Keep out of trouble with copper. Use Revere Copper Water Tube for radiant panel heating, hot and cold water lines, underground service lines, processing lines, waste lines and vent stacks. See your Revere Distributor for your needs. And if you have technical problems involving the best way to use Revere Copper Water Tube, one of our Technical Advisors will be glad to help.

23,969 LBS. of REVERE COPPER WATER TUBE were used for the plumbing lines in the Natick Senior High School, in sizes from ½" to 5". Installation would have been slower, more costly, if threaded pipe had been used in the close quarters shown in photo above. There are no wrench-room worries when you use Revere Copper Water Tube and solder fittings.



WITH NON-RUSTING Revere Copper Water Tube on the job there is no loss of flow or pressure, no allowance in pipe size required as would be the case with rustable pipe.

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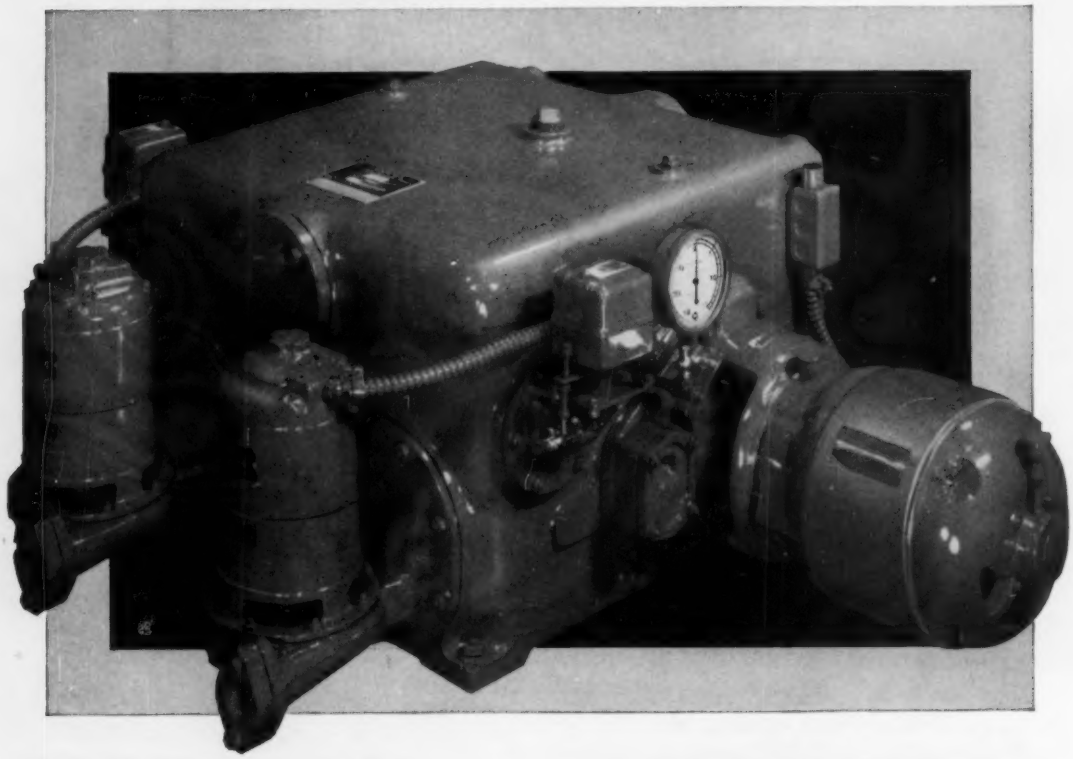
THIS NEW VACUUM HEATING PUMP

HAS THE INCREASED AIR CAPACITY EFFICIENT HEATING PRACTICE DEMANDS



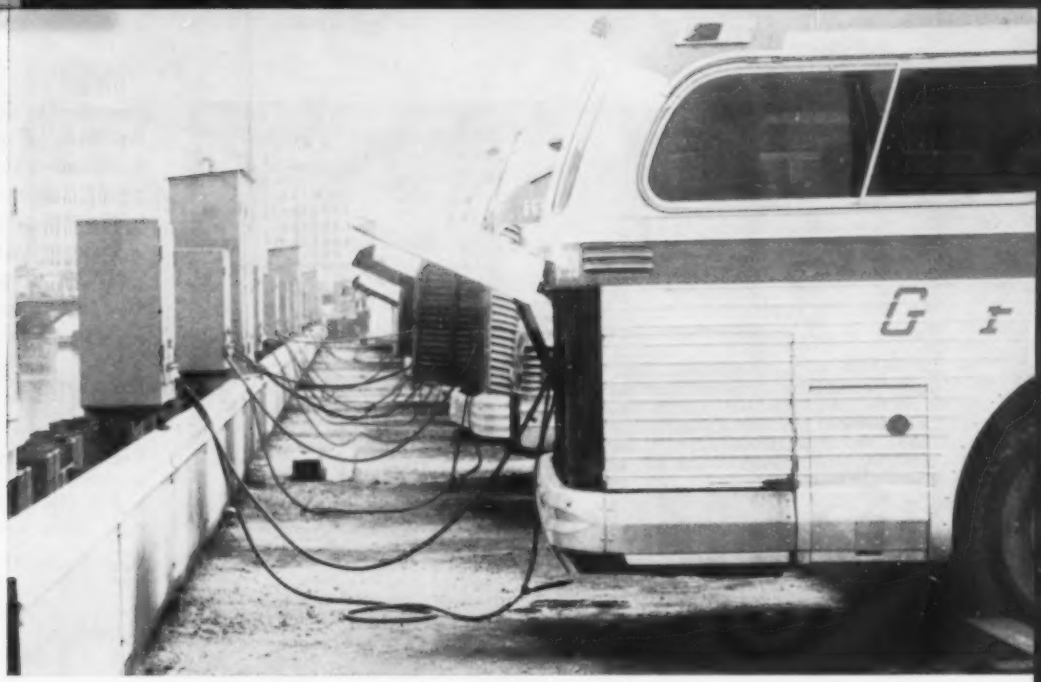
It's the Nash CSM

Designed and manufactured by the organization that made the Jennings Manifold Heating Pump standard of the Heating Industry, the new CSM incorporates every desirable feature architects, engineers, owners and operators have sought. Employing separate air and water pump elements, each with its own motor and each independently controlled by its own automatic switch, the capacities and arrangement may be widely varied to meet job conditions. For the first time, the engineer has the choice of realistic water and air capacities required for rapid system response without wasteful overheating.

These pumps possess many other features which permit a more efficient utilization of fuel and minimum use of electric power. Low, low returns reduce installation costs and usually eliminate putting the pump in a pit. Simplicity and efficient operation reduce supervision and maintenance costs. Information regarding this new heating pump development is available immediately upon request.

- Increased air capacity induces rapid system response without wasteful overheating.
- Separate air and water pumps individually selected to meet actual job requirements.
- Control system that operates individual pumps only when needed.
- Flexibility permitting addition of radiation without changing basic pump installation.
- Low, low, return line connection.

NASH ENGINEERING COMPANY
437 WILSON, SO. NORWALK, CONN.



INSULATED CEMENT-ASBESTOS BOARD CABINETS, mounted on pilings, house heat exchangers and flexible hose connections. The low horizontal box, constructed of the same materials, encloses bare piping, which branches off through insulated ducts to cabinets

"Piggy Back" Heating System Prevents Outdoor Bus Freeze-Up

. . . protects engine jackets and heating coils in —10 F weather

By Robert E. Hattis
Senior Partner
and
Edwin Shuman
Project Engineer,
Robert E. Hattis,
Consulting Engineers

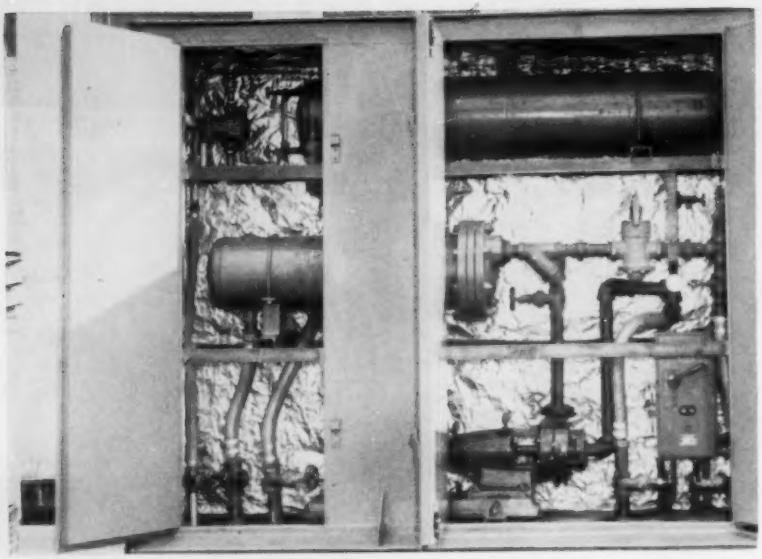
• A bus heating system capable of heating 80 buses in outdoor storage serves Chicago's new Greyhound service center. From the main heating boilers, hot water is circulated to eight perimeter main heat exchanger stations, each of which serves five hose cabinets, which in turn serve two buses each.

To SERVICE part of its nationwide fleet of buses, the Greyhound Corp.'s new 72,940 sq ft one story service center in Chicago houses a reclamation shop, service wing, repair shops, and offices. A partial second story area contains drivers' dormitories, lounges, and a small restaurant.

The "L" shaped outdoor bus parking area — 55,000 sq ft exclusive of driveways and ramps — is designed so that 80 buses, each from 30 to 40 ft long, can be temporarily stored up to 48 hours between runs.

Winter Freeze-Ups a Problem

How to keep bus engine cooling systems and interior heating systems



MAIN HEAT EXCHANGER STATIONS consist of one water-to-water shell and tube heat exchanger, a 50 gpm close-coupled pump, a small open-type expansion tank, and piping connections to the mains below. Equipment is insulated, compactly arranged and easily accessible

from freezing in winter was the big problem. Anti-freeze solutions are not used in the buses. Since the number of buses requiring temporary storage was too great for indoor storage, an economical solution had to be found.

The consulting engineers, although responsible for the design of the heating system in the new building, were not originally involved in this problem. Until the time when the new service center was in the planning stage, the Greyhound Corp. was using an outdoor bus heating system which consisted of a small oil fired hot water heating boiler, a circulating pump, and an expansion tank, all piped together and contained within a sheet metal housing. The external hot water flow and return piping was extended on the ground to several hose cabinets, each of which could serve two buses by means of hose connections from these cabinets to the engine blocks. Each boiler unit was served by its own 275 gal fuel oil storage tank which had to be installed external to the housing containing the boiler, pump, etc. Because of the number of these self-contained units that would be required, the installed first cost of these units would have been a considerable figure.

To reduce costs, it was suggested that if a water-to-water heat exchanger were provided in lieu of a boiler, the main building hot water heating system could be utilized to provide the primary heat source. Very little additional capacity would be required in the main heating boilers to handle this load.

The consulting engineers presented the Greyhound Corp. with a plan for such a design and were commissioned to develop the complete system.

Main Building Heated Directly

The main building heating system consists of two 200 hp nominal rated oil fired boilers, aranged for direct hot water heating service.

Two 600 gpm pumps serve the main building, two 400 gpm pumps serve the reclamation area, and two 100 gpm pumps serve the bus heating system.

The pumps are of the centrifugal type with mechanical seals. In each system one pump carries the total load, the second pump being a standby.

The suction side of each pump is connected to the main boiler header; the discharge piping from each pump is extended to its load, the return piping from the load being connected to the main boiler return header.

A single closed type expansion tank serves the complete system. Oil burners are automatically modulated through proper control devices to maintain a 210 F water temperature leaving the boilers at all times.

Eight Heat Exchangers Used

The bus heating system consists of eight main heat exchanger stations, each of which serves five hose cabinet stations, which in turn serve two buses each, making a total of 80 buses which can be connected to the system at any one time.

Each of the main heat exchanger stations consists of one water-to-water shell and tube heat exchanger, with capacity to heat 50 gpm of engine jacket water from 150 to 160 F when supplied with 12½ gpm of boiler water entering at 210 F. Boiler water is circulated through the shell side, and engine jacket water through the tubes. A 50 gpm close-coupled pump circulates the engine jacket water through flow and return piping to the five hose cabinets.

The hose cabinet system is balanced by means of lubricated plug cocks so that each cabinet receives 10 gpm of water and each bus, 5 gpm. This is sufficient to maintain engine jackets and bus heating coils well above the freezing point in −10 F weather.

A pressure regulating valve is installed in the pump discharge line, set to maintain a constant 12 psi pressure on the hose cabinet system to prevent leakage of coils as a result of excess pressure. Heat exchanger, pump, and a small open type expansion tank with automatic water make-up are installed and piped in a small, compact, insulated metal housing.

Install Cabinets on Piling

A rather unique method was devised for the installation of heat exchanger stations and hose cabinets.

The parking lot, on the east and south, fronts on the Chicago river. To prevent the earth fill from collapsing into or being washed away by the river, interlocking sheet steel piling driven some 60 ft down below water level to bedrock extends around the entire east and south sides of the parking lot.

To gain additional parking space, and to provide protection for both heat exchanger station and hose cabinets from buses being backed into them, these units are installed on top of the sheet piling which extends 3 ft above ground. Heavy steel brackets are welded to the sheet piling, and the housings are bolted to these brackets. To provide additional protection, I-beams are welded to the piling, extending upwards to the tops of the cabinets. Finally, the cabinets are bolted to the I-beams.

Insulated Piping Box

Since the bottoms of the cabinets are some 3 ft above ground, the service piping and electrical conduit and wiring are above ground, supported from the piling. This permits simple flexible connections with a minimum of fittings at all heat exchanger and hose cabinet locations.

With all piping exposed to freezing temperatures — except those sections of boiler water flow and return and cold water make-up, which were run underground from the building wall to the piling — insulation became another problem. All exposed piping could have been insulated individually, but this would have been too costly. Therefore, all piping is bare, supported from heavy band iron brackets which were welded to the piling at 8 ft intervals. The entire piping assembly is enclosed in a weather-proof insulated box extending horizontally for the entire run. Two in. thick cement-asbestos board is the material used.

The board was cut in 8 ft long sections and drilled so that it could be bolted to the same brackets which support the piping. This also provides accessibility to the piping if repair or replacement is ever required. All exposed edges of the board were treated with a waterproof mastic. To prevent warping between supports, the entire housing is banded with steel strapping at short intervals.

Cabinets and Ducts Insulated

Connections from the mains in this housing to the various cabinets are flexible and are installed inside insulated sheet metal ducts extending from the cement-asbestos board housing into the cabinets. The cabinets and ducts are insulated with glass fiber.

The outdoor bus heating system, in operation for more than a year, has functioned satisfactorily, with only minor adjustments necessary from time to time.

The Greyhound Corp. has had a similar system installed for eight buses in the downtown Chicago passenger terminal. They are considering similar systems in all of their main service terminals throughout the country.

The architects were Earle Webster of the Greyhound Corp., and Victor L. Charn. The general contractor was Ragnar Benson, Inc., and the heating contractor, Chicago Conditionaire Co.

[Photographs courtesy Bell & Gosset Co.]

118 ROOM AIR CONDITIONERS USED

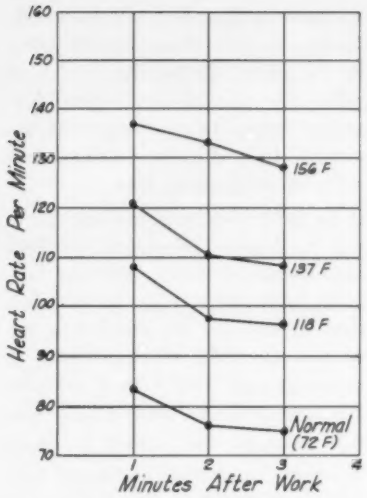
118 ROOM AIR CONDITIONERS installed in office building for Collins Radio Co., Cedar Rapids, Iowa, were chosen for flexibility in leased quarters, according to Amana Refrigeration, Inc.

CUSTOMERS VIEW EQUIPMENT ROOM

VIEW WINDOWS TO THE EQUIPMENT ROOM are provided in the public corridor of the new Community Bank, Burbank, Calif., to let customers see its 25 ton packaged central air conditioning plant, according to the United States Air Conditioning Corp.

- **Exposure to short rest periods in air conditioned areas improves recovery of heart rate and body temperature, thereby reducing stress and fatigue. Tests show that this provision for workers' health and comfort pays off. Less absenteeism, less employee turnover, greater efficiency, and increased production result in savings much greater than the cost of air conditioning.**
- **Control of humidity is as important as control of temperature when temperature reaches 80 F DB or above.**
- **Air movement alone, without mechanical control of temperature or humidity, helps reduce stress in work areas.**

By L. A. Brouha, M.D.
Head, Physiology Div.
Haskell Laboratory
E. I. du Pont de Nemours & Co., Inc.



1 HEART RATE RECOVERY after five minutes exercise and three minutes rest is progressively slower under higher temperatures

Air Conditioned Rest Areas

AIR CONDITIONED recovery rooms for short rest periods several times a day can help make workers who labor in temperatures up to 156 F as productive and generally healthy as those who labor in ordinary temperatures. This is especially important in high temperature industries, where withering heat can send a worker home at the end of a day with a light fever and unnecessary heart stress.

Several years of research for both the du Pont Co. and the Aluminum Co. of Canada, Ltd., prove that the warmer and more humid the work environment, the harder the job and the greater the physiological stress on the worker. Keeping him cool — if only during rest periods between shifts or work cycles — decreases that stress, making him a healthier, happier, more productive worker.

The project, which was started in 1945 by the Canadian firm in its aluminum smelting plants, is still being carried on and expanded. The purpose is to determine the effect of environmental temperatures and humidity on heart rate recovery, an important key to workers' health under adverse temperature conditions. Also charted is the effect of work area temperatures on workers' morale, which along with physical exhaustion plays an important role in rate of productivity.

Conditioning Rest Areas Pays

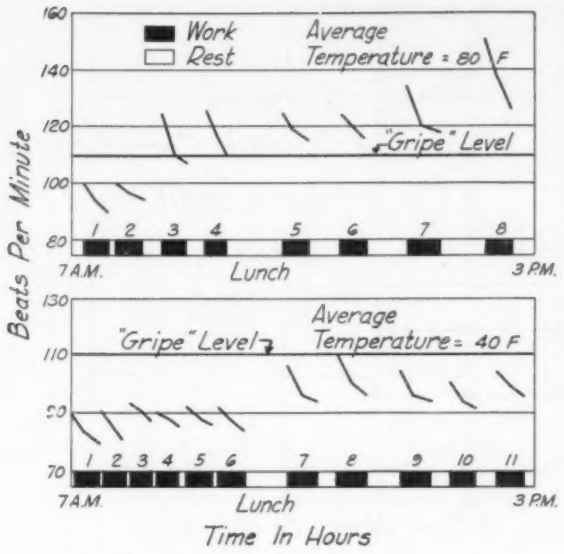
Already from the studies has come a mass of statistics indicating that air conditioning — even on a partial if not plant wide scale — represents a good money saving investment for industrial plants.

Without disclosing production increases, officials of the Aluminum Co. of Canada said savings far outweighed the cost of the air conditioning. A sharp drop in absenteeism and the rate of turnover among employees also followed installation of air conditioning.

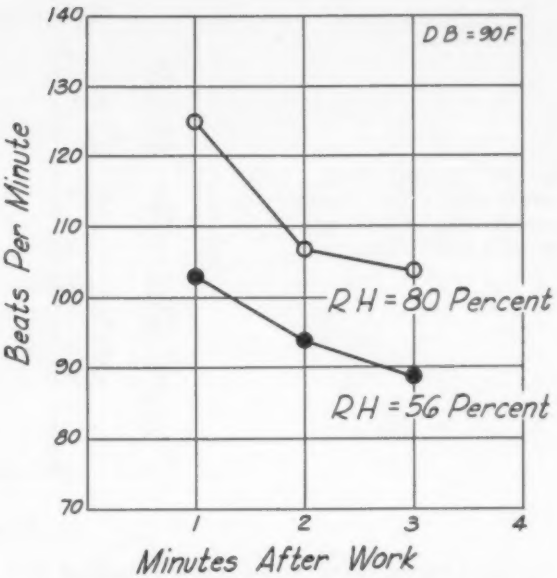
Naturally, it is impractical to air condition most high temperature industrial processing areas for worker comfort, because of the tremendous heat load. However, by simply air conditioning a small room where workers may rest between work periods, many of the health benefits of total air conditioning can be achieved at a fraction of the expense. In other words, the benefits of exposure to adequately controlled temperature-humidity conditions during properly spaced rest periods enable the worker to return to his basic resting level and thereby reduce considerably the physiological stress and fatigue.

How Tests Were Conducted

Test groups in all of the Canadian experiments included company employees and a group of 12 university students between 22 and 25 years of age. Students of about the same age as many workers in the hot areas of the smelting plants were chosen,



2 RECOVERY RATE is slower with each successive work-rest cycle during the day, even at lower temperatures. Workers "gripe" at conditions above "gripe" level



3 HUMIDITY'S INFLUENCE on heart recovery is just as important as temperature's when temperature is above 80 F DB

Reduce Physiological Stress

. . . where it is not practical to air condition an entire industrial plant — in certain high temperature industries, for example

so that some of the tests could be conducted under controlled laboratory conditions without interrupting production. Physical work assigned to the test group required the same energy as the work usually performed by employees.

Temperature and humidity conditions were also set up to duplicate work conditions in a typical boiler room or foundry and for summer conditions in a normal manufacturing plant.

All tests were designed to measure body temperature and heart rates before and after controlled work period. Every test was repeated 10 times under identical conditions to provide an accurate norm.

Test group members were acclimatized to heat by working in various test temperatures for one month before tests were started.

Before each test, subjects rested one-half hour at normal room temperatures of 72 and 75 F. They then entered the test room and sat quietly for 10 minutes before beginning the physical exertion test.

Rate Rises with Temperature

The effect of moderate work on the heart under varying heat conditions, with a relative humidity of about 25 percent is shown in Fig. 1. Subjects stepped up on an 8 in. platform and then down, 30 times per minute for five minutes. They then sat down to rest in the same room, where for the first three minutes their heart recovery was measured at one minute intervals.

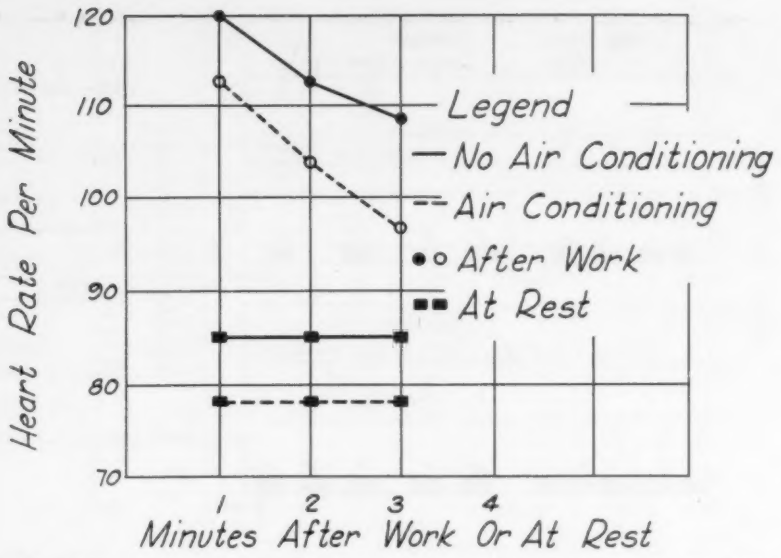
Results showed a sharp increase in heart rate as the temperature increased; the higher the temperature, the less recovery.

For example, the average heart rate after the platform step test in 72 F temperature was 83 beats per minute after the first minute of rest. One minute later, it dropped to 76 beats, and three minutes after the five minute work stint, the heart rate was back to the normal 75 beats per minute.

However, students tested in average temperatures of 156 F ended the first minute of the postwork rest period with a heart rate of 136. At the end of the three minutes' rest, their average heart rate was still 130 beats per minute.

The effects of simulated conditions in a foundry or boiler room — and in many industrial plants in summer — are shown in Fig. 1 by the 137 F and 118 F curves.

More tests in many different industrial experiments have verified that with each successive work period during the day, the heart recov-



4 AIR CONDITIONED REST AREAS result in better heart recovery from physiological stress than do non-air conditioned rest areas

ery rate becomes slower. At the end of the eighth cycle, the heart beats much faster than at the end of the first work period. This is true even at lower working area temperatures, as shown in Fig. 2.

Workers Gripe If Rate's High

At an average work temperature of 40 F, the heart rate remained much nearer normal throughout the eight cycle day than at an average work temperature of 82 F.

Especially interesting in Fig. 2 is the position of the various curves in relation to the 110 beats per minute line. That line represents the "no gripe" level for workers. So long as their heart rate was not above 110 beats per minute at one minute recovery, they had no complaints about working conditions. Above that level, workers began complaining about the heat, the condition of the air in the work area, and the amount of work.

Complaints increased in direct ratio to the increased stress on the heart, with a consequent decrease in worker efficiency output. Even the hour lunch period, in the case of the 82 F workers, and the 45 minute lunch period for the second group working in temperatures of 40 F, did not bring their average heart rate back to normal. One reason, of course, is that the digestive process naturally increases the heart rate.

Humidity Just As Important

Humidity is just as important as temperature in determining the rate of heart recovery when the temperature is above 80 F DB. This is because body cooling under such conditions is not only limited by the ability to perspire but also by the ability of the atmosphere to vaporize perspiration. At air temperatures around 100 F and above, a small increase in humidity can greatly modify the physiological effects of environment and change a relatively easy job into a hard physical performance.

The effect of humidity on heart recovery at temperatures above 80 F DB is shown in Fig. 3. With temperature constant at 99 F, the lower humidity of 56 percent entailed much less stress on the worker's heart and within three minutes after ceasing work the average heart rate had returned to a little less than 90 beats per minute. Working under a relative humidity of 80 percent at the same temperature was much harder on the heart, as shown by the top line in Fig. 3. Recovery during the first two minutes was more rapid at the higher humidity, but workers under those conditions never regained as satisfactory a heart rate level after three minutes rest or more as did the workers under 56 percent humidity.

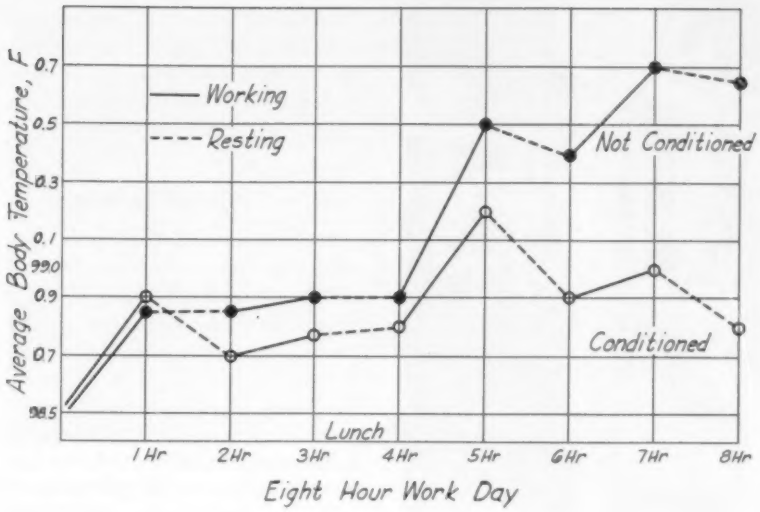
Additional studies confirm that lower temperature and humidity exert less stress on the heart. Not only is heart rate greater at higher temperature and humidity, but recovery is progressively slower as temperature and humidity increase.

When only light work is involved in temperatures under 80 F DB, humidity differences seem to have little effect in producing physiological stress. This is because light work involves little, if any, perspiration — one of nature's cooling mechanisms in the human body.

In heavy physical labor producing perspiration, however, the humidity must be sufficiently low to absorb most of the moisture of perspiration for maximum comfort and relief of stress. Another factor involves the differences in how the body acclimatizes itself to dry or moist heat.

Acclimatization to dry heat includes, principally, the ability to produce more perspiration. Acclimatization to moist heat involves modifications in the circulatory functions. This is a slower process than the relatively simple process of perspiration and involves more stress on the worker's heart and circulatory system. Thus, acclimatization to one kind of heat is only a partial acclimatization to the other kind.

Simple air movement alone, without mechanical control of the temperature or humidity, often helps reduce physiological stress. An experiment at the du Pont Co. showed that crea-



5 BODY TEMPERATURE INCREASE during the day is less where rest areas are air conditioned than where they are not

"Even when no physical effort is involved, control of temperature and humidity means less work for the heart."

tion of a 9 mph breeze through the work area reduces the heart rate about 10 percent. While this experiment was conducted at 90 F heat and 65 percent relative humidity, other studies indicated that the same conclusions could be drawn under several combinations of high temperature and humidity.

Reduce Stress and Fatigue

That air conditioned rest periods can reduce physiological stress and fatigue is shown in Fig. 4. Heart recovery rates are compared under similar work conditions but at rest conditions with two different temperature-humidity levels. After each work cycle of an hour, the two groups rested, one in a non-air conditioned room, the other in an air conditioned room where a temperature of 85 F and humidity conditions of 40 and 45 percent were maintained.

Subjects were tested both after work and at rest. In both cases, air conditioning resulted in a much better heart recovery. The difference in heart rates indicates that even when no physical effort is involved, control of temperature and humidity means less work for the heart.

Workers who rested in the air conditioned area not only had less stress on their hearts after work but recovered even faster during the rest period than those exposed to the hot conditions during rest. Even more important, during the rest period the maximum recovery level for the non-air conditioned men was higher, even though it was computed after a one hour rest.

Temperatures used in the air conditioned test room charted in Fig. 4 are not meant to be optimum conditions. The DB temperature in any area can vary by the season, being higher in summer than in winter.

The important thing is to maintain a low relative humidity so that the men will dry quickly. Dry air in the rest rooms permits a higher evaporative cooling rate, which helps the men recover more rapidly and keep their body temperatures down.

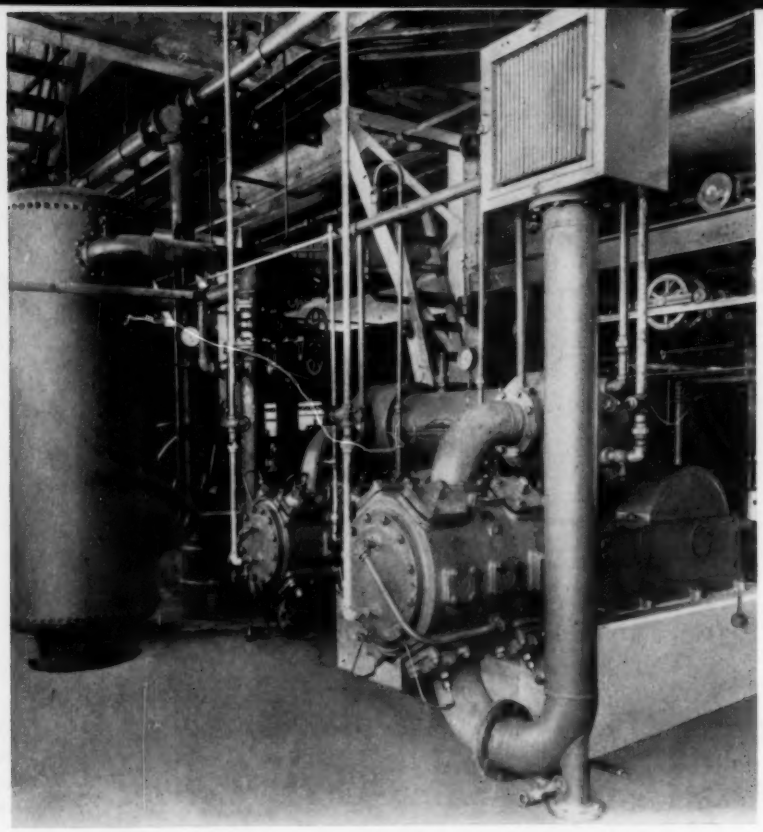
To avoid any unpleasant chilling sensation by moving abruptly from a hot surrounding to a much cooler one, it was found best to let the men themselves regulate the temperature of their rest area within a reasonable range. The men adjust the temperature to suit daily conditions.

Workers Actually Run Fevers

In addition to increased demands on the heart, excesses of heat and humidity also cause industrial workers to actually run a temperature during the day. If they're exposed to air conditioned rest rooms between between work periods, workers in high temperature areas wind up with negligible increases in their body temperatures. When the rest rooms are not air conditioned, they may go home at the end of the day with a fever of 1 F or higher.

These findings are shown in Fig. 5, which charts workers' average body temperatures during four alternate work and rest periods over an eight hour day. Again, the sharp increases in the first hour of work following lunch are caused in part by increased action of the body organs involved in digestion.

For a selected bibliography of articles previously published in HPAC on the profitability of industrial air conditioning, see the August 1954 *HPAC, pp.* 119, 120.



1 DRAIN VALVE is essential to remove moisture which condenses from intake air before the air reaches the compressor, to prevent damage to suction and discharge valves caused by water drops washing away cylinder oil

DO YOU MAKE THESE MISTAKES IN

Piping Compressed Air?

By S. A. Herrick
Compressed Air and Gas Institute

• Common piping mistakes often cause unnecessary breakdowns and shutdowns of compressed air systems. Ten frequent errors which can be easily avoided or corrected are:

1) Undersized suction pipe
2) Undersized distribution pipes
3) Lack of drain valves in low spots
4) Inadequately supported pipe weight
5) No allowance for discharge pipe expansion
6) Improperly sloped pipe lines
7) Stagnant air in air receiver
8) Jacket cooling water less than 15 F above inlet air temperature
9) Unprotected interior of concrete air supply pipe
10) Inadequate safety valves

COMPRESSED AIR is a vital modern tool. By proper piping, some operators save money. Others waste it by expensive mistakes in piping, which can easily be avoided.

Size Suction Pipe Adequately

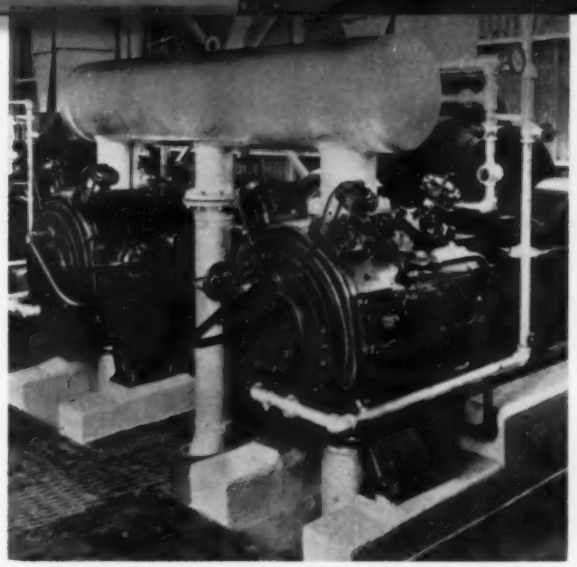
Some compressor operators save money by taking compressor suction air from the naturally shady side of a factory, or from the cooler, cleaner interior of the building itself. (Fig. 1). Hot summer sun can be expensive. And a cool air supply, away from spray booths or other contaminants, can mean less maintenance and more cubic feet of air per dollar.

No one intentionally uses a long, undersized suction pipe with velocities over 2000 fpm. This results in a high friction loss which consumes horsepower and means less air where it's needed. Yet, one Texas refinery did just this on some angle gas engine compressors. Perhaps they were trying to save money by supplying inlet air for several engines through just one suction pipe.

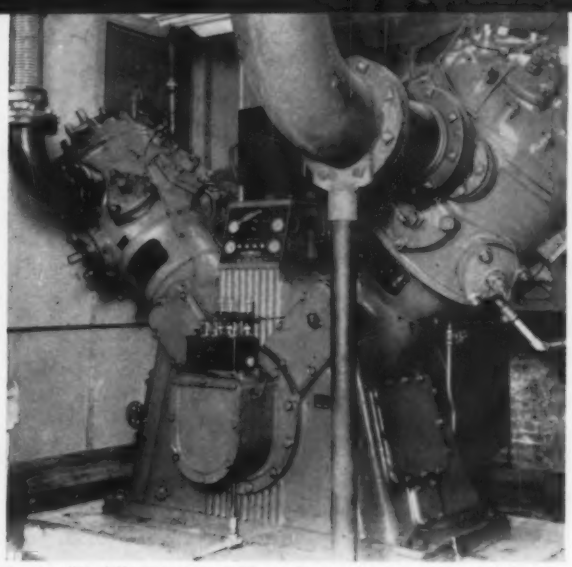
This can work fine, if the pipe is big enough. But in this case, it wasn't, and it prevented the installation from meeting its guaranteed performance. Of course, the expense of correcting this, plus plant shutdown, was far more than to have originally installed the correct size pipe.

Some installations bring in their air supply to the compressor by means of underground concrete pipe. This, too, can be excellent. But in a St. Louis factory, failure to apply a protective coat inside the pipe caused the compressor to break down when bits of concrete crumbled from the pipe and were sucked into the compressor cylinder.

Another good practice is providing large volume in the suction line just before the compressor intake flange. Acting as a pulsation dampener, this volume reduces horsepower requirements. (Fig. 2). Since intake air often loses moisture before reaching the compressor, a drain valve similar to that shown in Fig. 1, or trap, is essential. Droplets of water wash away cylinder oil and often damage suction and discharge valves.



2 LARGE VOLUME IN SUCTION LINE just before compressor intake flange dampens pulsations, reduces horsepower requirements



3 PREVENTION OF PIPE STRAIN by the use of flexible pipe or floor support eliminates problem of cylinder deflection caused by excessive pipe weight or misalignment

Engineers at one steel mill forgot that their suction air was frequently near the dew point and decided to cool their compressor cylinder jackets with nearby lake water. Since the unit had worked well during the summer, a December breakdown was puzzling, until they realized jacket water was being supplied at 35 F.

This cold liquid chilled the air enough to knock out moisture inside the cylinder, causing severe cylinder, piston and valve wear. They solved the problem by keeping jacket cooling water at least 15 F above the inlet air temperature. This was done by using warm inter- or aftercooler water to raise the temperature.

Eliminate Pipe Strain

Another quickly eliminated trouble is cylinder deflection caused by excessive pipe weight or misalignment. There have been several reports of broken cylinders where the cause of failure proved to be either (1) hoping the cylinder alone would hold up hundreds of pounds of extra dead weight, or (2) using the cylinder flange as a fulcrum to pry suction or discharge pipe into place that otherwise just wouldn't fit.

One good way around this problem is shown in Fig. 3 — either floor supports or flexible pipe.

Another type of cylinder stress, which can be serious if forgotten, is thermal expansion. A toothpaste manufacturer mounted his small compressor on a balcony because of space limitations. The discharge piping ran vertically downward for a long distance — with no allowance for pipe expansion — before reaching the aftercooler and receiver.

The cylinder held all right, but as the hot pipe expanded, it forced the cylinder right off the frame. No one had told him that the aftercooler should be located close to the compressor.

Use Aftercooler for Protection

The advantages of having a suitable aftercooler, complete with separator and automatic moisture trap, cannot be over-emphasized. Fig. 4 shows an installation complete with bypass connections and valves to permit temporary withdrawal of the aftercooler from service for cleaning without interrupting operations.

A good aftercooler not only pays its way by removing moisture and oil from the compressed air under normal service conditions, but also protects the system against excessive temperatures, should failure of compressor cooling water and cylinder lubrication occur.

Prevent Stagnation in Receiver

An air receiver should always be piped so that air flows through it and never stagnates in any part of it. A receiver contributes much to any air system. It helps smooth the air flow to the distribution lines by reducing pulsations. It separates entrained moisture due to reduced velocities. And it acts as a reservoir to meet sudden air requirements.

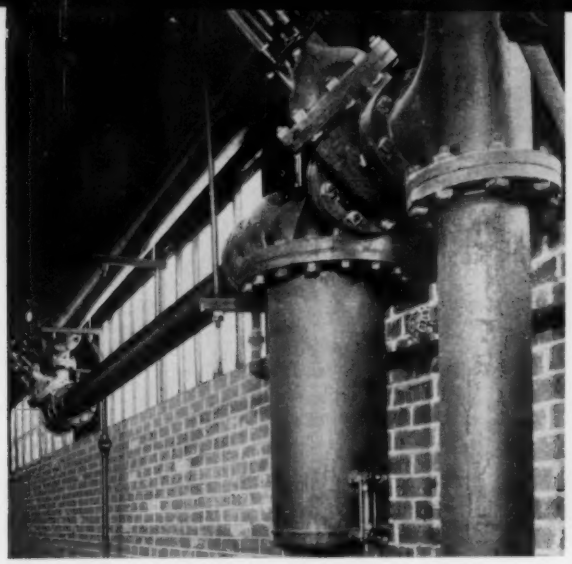
However, to secure maximum advantage from a receiver, it should be connected to prevent stagnation, similar to Fig. 1. Note that the entrance and exit are not only located at the top and bottom of this air tank, but are also at right angles.

If inlet and discharge receiver pipes are located directly opposite each other, the tendency for high velocity discharge air would be to flow from one directly to the other without circulating through the receiver, thus not permitting the air time to drop out moisture and oil.

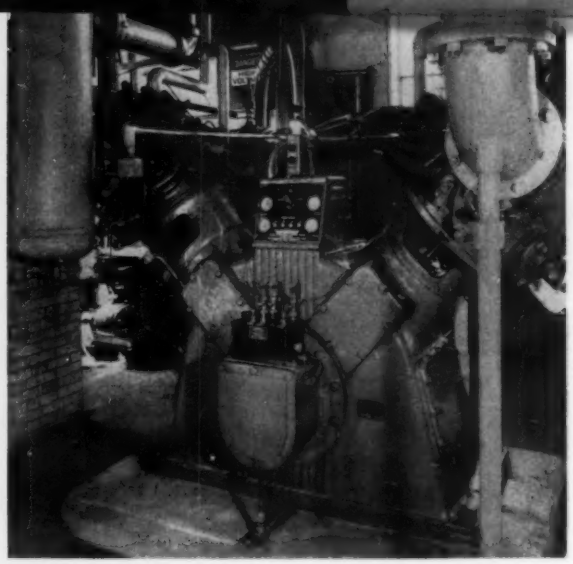
A receiver should always be installed so that its bottom drain can be checked often. Collected oil and water cannot only reduce effective internal volume, but can also freeze inside the tank on outdoor installations.

Avoid Condensation in Air Line

A small tool manufacturing company, was bothered by excessive water coming out of the air line and into hand tools. This is quite common, since air leaving any aftercooler is saturated with water vapor. When the temperature drops, as it did in the main distribution lines in some parts of this plant, the vapor condensed.



4 AFTERCOOLER, with separator and automatic moisture trap, removes moisture and oil from compressed air, protects system against excessive temperatures



5 DISCHARGE PULSATION DAMPENER (left) helps prevent pipe vibration. Vibration is often caused by inadequate support or faulty connection

This factory had 20 air tool operators, each of whom spent 15 minutes a day blowing the moisture out of his tools before beginning productive work. In a year this amounted to over a thousand man-hours.

They cured the trouble with two simple remedies. First, when connecting branch lines, they tapped the main air line at the top, not the bottom. Secondly, they sloped all lines so that condensate flowed toward predetermined collection points, where it is regularly drained off.

These collection points can be inexpensive and easy drain legs — short pieces of pipe with a bottom drain valve, or automatic drain trap. Installed in centralized spots throughout the plant they collect moisture for easy removal.

Cut Vibration, Pressure Drop

The compressor is often thought responsible for pipe vibration when, actually, inadequate support or faulty connection is responsible. If the vibration stops when the compressor is unloaded, faulty piping can usually be spotted. A helpful device is the discharge pulsation dampener shown in Fig. 5.

One excellent rule of thumb is to use good spring hangers for pipe support, and to avoid sharp bends wherever possible.

One large pipe line company overlooked pressure drop that always occurs in long, undersized distribution pipes. At one pumping station, because of building costs, they thought it more economical to install the air starting compressor and receiver 1200 ft away from the engine. The engine wouldn't start.

The solution was to put an auxiliary receiver next to the engine. In this way, there was a large volume of air available for short periods when needed. This same solution has been applied to air lifts in garages and elsewhere.

Solve General Problems

Inside another plant a trench under a heavily traveled area had to be used for discharge piping from the compressor to the aftercooler-receiver. This low spot collected oil and water, causing trouble which could have been prevented by an automatic drain.

Some air piping layouts have a closed loop system, which may have to be opened up for cleaning. Hot air sometimes carbonizes oil, forming gum deposits on the inside of the distribution pipe. This gum is usually removed by steam cleaning. With the closed loop system, there is often no way to get this sludge blown out of the piping, unless the joints are disconnected.

In an Eastern brewery using steam on the second floor, the booster compressor is in the basement. During installation, a drain was negligently omitted in the lowest part of the line. Of course, condensate collected during normal shutdowns. Eventually the condensate seeped back through the discharge valves and into the cylinder, forcing the head off the compressor during startup.

This can happen also when compressing air. This problem could have been avoided by installing the drain valve when the piping was being hooked up. (Fig. 1).

Many locations requiring steam driven compressors utilize either a reciprocating engine, or turbine-gear drive. With long uninsulated steam lines, condensate — not to mention pressure loss — can be a severe problem. It is impossible to overestimate the importance of moisture removal in a situation like this.

Install Adequate Safety Valves

Adequate safety valves are an essential part of a compressed air system. It is good practice to install a pop type safety valve before each main shutoff valve and on each intercooler of a multistage machine. This affords protection in case a forgetful operator closes down the air system while the compressor is still pumping.

Thus, common sense piping precautions can save many times their cost by averting unnecessary plant shutdowns.

By William Hurd Hillyer

Letter Writing Pays Off in Court

PAPERWORK, of supreme importance to the mechanical (heating, piping and air conditioning) contractor, is too often neglected. There is power in the written word, whereas the memory-entrusted oral statement can lead to money troubles. A recent case shows the practical necessity of writing letters. [All names herein are fictitious.]

Brickenwood Builders, general contracting firm on a high school job, entered into an *oral* subcontract with Convecto Co. for installation of the heating system and related services. Terms provided that the subcontractor was to do all work in conformity with the architect's specifications and that Convecto would be responsible for any and all defects which might appear within a year after the owner accepted the contract.

After the heating system was installed and approved, Convecto received $28,000. Nearly a year later, the architect wrote Brickenwood that inspection had disclosed the following defects:

1) The burner was set approximately 4 in. too high. It should have been only 1 in. above the bottom of the cold water leg of the boilers.

2) The pilot assembly was set with the flame electrode 90 deg from the ignition electrode instead of 180 deg, as shown in drawings. The flame rod was not bent to a horizontal position.

3) The firing pressure gage was mounted on the steam loop instead of on the fuel line between the firing valve and burner. Omitted were a master lubricated cutoff and a pilot gas regulator.

4) The lever handle from an LP gas valve was installed ahead of the control valve.

5) No test cock was installed for leak-testing the main cutoff. The piping arrangement was not as shown on the drawing.

6) The high voltage circuit for the toggle switch and signal light was taken from the low voltage side of the protecto-relay base, contrary to the drawing and to Underwriters' Laboratories rulings.

These reported defects should have prompted the heating subcontractor to obtain from the general contractor a written reconcilement when corrected. Convecto's failure to get the written O.K. is presumably the reason why the subcontractor was sued by the general contractor for $1000.

Brickenwood Builders claimed in court that they had informed the subcontractor of the contents of the architect's letter. Brickenwood, conceding that No. 6 was part of the electrical instead of the heating job, complained that the shortcomings were "never corrected." So, said Brickenwood, they had to employ an outside firm to repair the defects and pay that company the amount named.

The builders brought forth testimony by one of their own partners, by the firm called in to remedy the defects, and by the heating equipment manufacturer's sales agent.

On the other hand, Convecto, while "honestly admitting" certain defects, insisted that these had all been corrected by their employees immediately upon notification. Their steamfitter and two of their other workmen were "positive" in testifying to the same effect.

Here was a case of conflicting testimony, with no writings in support of the subcontractor's defense. Fortunately for him, the trial judge chose to believe his witnesses rather than those of the general contractor. But it might just as well have gone the other way.

Indeed, the court of appeals, while sustaining the lower court's judgment in favor of the subcontractor, said that a "serious question . . . of fact" was posed.

[Note: While this discussion applies to an actual case, it should be remembered that legal rules vary in different states.]

WILLIAM HURD HILLYER, author of this regular feature, is a contributor to a number of banking and financial publications and has written several books on business. A former vice president of the Atlanta Trust Co., his work there gave him a practical legal background.

COMBUSTION EFFICIENCY CAN BE IMPROVED

Burning Heavy Fuel Oils

• **Smokeless, efficient burning of heavy fuel oil depends on knowledge of several things: the oil viscosities and the necessary preheat temperatures involved; factors determining firebox design, such as proportion of black surface to refractory surface, rate of heat release and draft conditions; the several methods of rating boilers; and the latest revisions of smoke control ordinances.**

By Kalman Steiner
C. Hoffberger Co.

QUESTION: What causes smoke?

Answer: Inefficient combustion, as far as liquid fuels are concerned.

QUESTION: How can combustion efficiency be improved?

Answer: By applying thorough knowledge of the fuel itself, the process of combustion, and control of combustion, and by adopting better practices.

The fuel oil industry as long as 25 years ago standardized the manufacture and marketing of fuel oil. Before 1929, these oils were designated chiefly by specific gravity. However, it became realized that of all the characteristics of a fuel oil, specific gravity is about the least important. Five revisions of the oil standards in the 25 years since the first set — known as Commercial Standards (CS) 12-29 — demonstrate their flexibility as technology developed.

While a pattern has been outlined, no rigid set of specifications has yet crystallized. Too many factors affect the production, distribution and utilization of fuel oils.

Knowing the variations that can occur in the viscosity of No. 5 oil, it is wise to equip the burner with a preheater. A temperature from 100 to 125 F is usually enough to break the viscosity of No. 5 sufficiently to permit satisfactory atomization. While not all No. 5 oils require a preheater, the law often does.

• *ignition and control must be closely regulated*

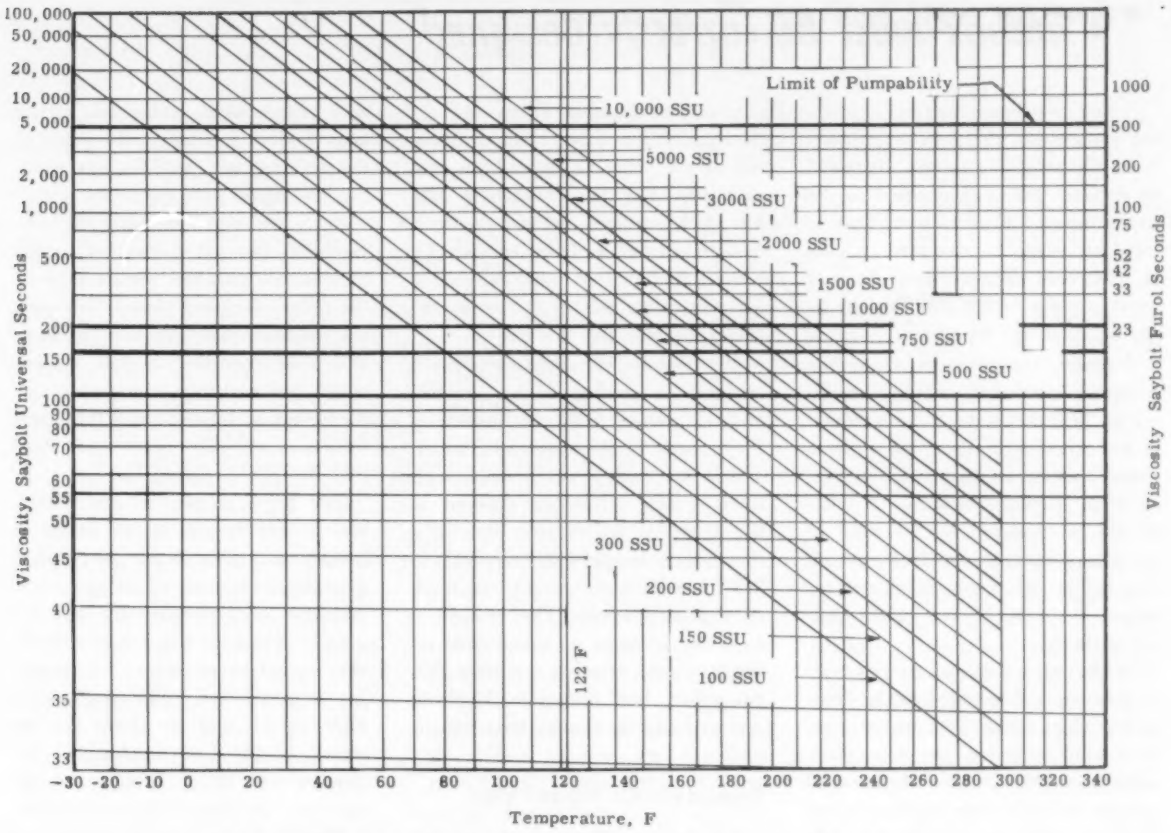
Pumpability is no problem with No. 5 oil. With No. 6 oil, there is the double problem of atomization once the oil arrives at the burner and also getting it there. Pumpability is determined by viscosity and temperature. Fig. 1 shows variation in viscosity with temperature change and the range usually considered as yielding an oil that can be pumped.

The final temperature to which No. 6 oil should be heated depends upon the type of burner employed and the oil viscosity. For most plants using No. 6 oil with horizontal rotary burners, the preheat temperature should be between 160 and 180 F. For larger plants equipped with pressure atomizing burners or steam atomizing burners, or a combination, the fuel should be heated to about 220 F. Such plants use electric heaters when starting cold boilers, then switch to steam as soon as it is available. Therefore, steam atomizing installations must have an auxiliary atomizing means for starting up — usually straight pressure atomization coupled with an electric preheater.

Plan Burner Control Carefully

Since larger plants are under constant supervision, they should not create a smoke nuisance, unless too low a turndown from peak capacity is attempted without shutting down surplus burners or boilers. Smaller plants depend extensively on automatic operation, and for the most part the rotary burner assumes this responsibility.

The author has written widely on fuels from his background of much practical experience and careful analysis. In recent years, he has summarized the fuel situation annually for HPAC. He is a member of HPAC's board of consulting and contributing editors.



1 PUMPABILITY OF FUEL OILS can be determined from this chart showing viscosity at varying temperatures

Thus, rotary burners frequently face the duty of starting up automatically in the morning after an overnight shutdown. Here the control problem is more delicate than in larger plants with supervised operation.

The installation must be carefully planned. An excellent scheme is to place the burner under temporary control to maintain hot boiler water, even though steam is not raised. Then by means of circulating oil pumps, a supply of hot oil can be made available at the burner atomizer when normal daytime operation resumes.

Various means are available for varying the firing rate with load fluctuations. On rotary burners, usually, a small electric motor is linked to a system of lever operated oil valve and air dampers to maintain the rate of fuel feed and air proportion in synchronism with the load. On pressure atomizers and steam atomizers, the more usual control is through variation of the fuel line pressure. In all cases, the more nearly constant the oil temperature remains, the smoother is the resulting control, with a resulting decrease in tendency toward smoke.

Codes Vary Heat Release Rates

With the boiler and its setting, just as with oil specifications, there are conflicting viewpoints. In firebox design, it is a question of low or high rates of heat release. The lower the design rate, of course, the larger the combustion chamber volume; conversely, the higher the rate of heat release, the smaller the volume.

Proponents of low heat release rates and large combustion volumes point out the advantages of longer refractory life, lower heat loss through the boiler setting, better ability to fire heavy for load pickup, and less tendency toward smoke.

With high heat release rates and smaller combustion volumes, it is said: that higher refractory temperatures assist in more efficient combustion; that smaller volumes give more compact settings; and that, generally, installation costs are less. This last factor, however, can easily be offset by higher refractory maintenance costs over the years.

Legally permissible rates of heat release vary by at least 100 percent, from 22,300 to 50,000 Btu per cu ft of volume per hr. Legal limits imposed by several cities and other authorities are shown in Fig. 2. A rate of 30,000 Btu per cu ft per hr — equivalent to an allowance of 1.6 cu ft per developed boiler hp — seems a good compromise value. This is the value established by the smoke abatement rules of Baltimore.

• firebox must be correctly designed

An alternative method for expressing combustion chamber proportions is the "envelope" concept, expressed as surface. The area exposed to the flame, upon which radiant heat is incident, whether refractory or metal, composes the envelope. A good average value is 100,000 Btu per hr per sq ft of envelope area.

Actually, the problem of firebox design is somewhat complicated. To set an arbitrary rate of heat release is an oversimplification. In conventional boilers, as distinguished from so-called package boilers, the rate should be modified by the ratio of refractory surface to black surface exposed to the flame. Black surface means the water-backed boiler heating surface.

In the refractory wall firebox boiler commonly designated as the "economic" type, and the horizontal return tubular boiler, the only black surface is that portion of the shell that forms the ceiling of the firebox. The side walls, rear or bridge wall, front wall, and floor or hearth form continuous refractory area. Large volume and low heat release rates are advised, to avoid high refractory temperature and high setting losses.

In the Scotch marine boiler, on the other hand, the flame is completely surrounded by black surfaces, the only refractory being the front firing cone or throat and the rear combustion chamber at the end of the combustion tube. Here the heat release rate may be stepped up considerably. The heat absorbing rate for black surfaces exposed to direct radiation from a flame exceeds by several fold that of pure convection surfaces, such as the tubes in the passes beyond the firebox.

Occasionally, the exposure to black surfaces is carried to an extreme and correction becomes necessary, for example in the water tube boiler, which has mostly water walls, with little if any refractory exposed to the flame. At low ratings, especially, the firebox temperature may run so low as to increase greatly the tendency toward smoke. The remedy is to cover an area of tubes with refractory, thus creating a surface that can reflect heat back into the flame and so build up firebox temperature.

Secondary Air Supply Vital

Another significant factor in firebox design is the method of introducing secondary air. In conventional boilers fired with horizontal rotary oil burners, secondary air enters either a single port in the front wall at floor level, or through a series of ports in the floor. This method has served well over the years. But experience with rotary burners firing Scotch boilers, and with mechanical atomizers firing large boilers, has taught the value of the 360 deg air port for surrounding the flame with secondary air.

By Scotch boiler is meant the conventional internal firebox of ample dimensions, with heat release rates in the range discussed above. This does not include the so-called package boiler of modified Scotch design, which has multiple tube passes and a combustion tube so small that combustion rates run upward of 150,000 Btu per cu ft per hr.

The firing of conventional Scotch boilers has taught us to design a firebox extension, sometimes called a doghouse because of its geometric similarity, incorporating the 360 deg air slot. Thus, the flame is completely surrounded by secondary air, resulting in rapid and clean combustion, and proving that the closer the air stream to the fuel supply, and the quicker and more intimate the admixture, the better the combustion.

The doghouse can be applied to firebox boilers, by setting the steel extension with its circumferential air slot in front of the ash pit and mounting the burner on it, as though firing a Scotch boiler. Besides improved combustion, the doghouse has the added advantage of shortening the fire, which is most important on a firebox boiler that has a shallow grate.

• boiler rating must satisfy maximum demand

One cannot design a boiler setting, or select a burner capacity to fire the boiler, without a knowledge of the boiler's rating. Yet no aspect of boiler technology is so elusive of definition. No standard exists for interpreting the meaning of rated boiler horsepower. The old rule of 10 sq ft of boiler heating surface per hp of capacity has long since been abandoned.

Although there can be considerable variation in the rate at which heating surface absorbs heat — depending, of course, on whether the heat transfer is by radiation or by convention — some sort of data must be used in referring to boiler output.

Double Rate Steel Boilers

Most boilers made today are low pressure, for heating. The Steel Boiler Institute issues two series of ratings for mechanically fired steel boilers, one for small sizes originally designated as residential, and one for larger sizes, designated as commercial in the first Codes.

Through the year 1953, boilers having up to 177 sq ft heating surface were given a *net* load rating based 17 sq ft steam radiation to 1 sq ft of boiler heating surface. The code allows 50 percent for piping and pickup loss; hence, the ratio of

Locality	Btu per cu ft per hr	Locality	Btu per cu ft per hr	Locality	Btu per cu ft Per hr
Asheville, N. C.	35,000	Indianapolis, Ind.		Pennsylvania	
Atlanta, Ga.	50,000	power boilers	35,000	Philadelphia, Penn.	
Baltimore, Md.	50,000	heating boilers	65,000	Phoenix, Ariz.	
Birmingham, Ala.		Jersey City, N. J.	30,000	Pittsburgh, Penn.	
Chicago, Ill.		Kansas City, Mo.		(Alleghany County)	
natural draft	32,000	Knoxville, Tenn.		Portland, Maine	
forced draft	48,000	heating boilers	25,000	Richmond, Va.	35,000
water walls	62,000	power boilers	35,000	Roanoke, Va.	
Cincinnati, Ohio	45,000	Los Angeles		Rochester, N. Y.	
		County, Cal.	40,000		
Cleveland, Ohio	30,000	Louisville, Ky.		St. Louis, Mo.	45,000
Columbia, S. C.		(Jefferson County)		San Francisco, Cal.	
Columbus, Ohio	35,000	Montreal, Quebec		Santa Clara County, Cal.	
Davenport, Iowa		Massachusetts		Syracuse, N. Y.	50,000
Denver, Col.		Miami, Fla.		Tacoma, Wash.	
Detroit, Mich.	32,000	Minneapolis, Minn.		Toronto, Ont.	
Elmira, N. Y.		Monroe, Mich.		Washington, D. C.	
Evansville, Ind.		Nashville, Tenn.		heating boilers	25,000
Grand Rapids, Mich.		New York, N. Y.	37,500	power boilers	30,000
Green Bay, Wis.		Niagara Falls, N. Y.		Waterloo, Iowa	40,000
Hudson County, N. J.		Omaha, Neb.		Watertown, N. Y.	
heating boilers	25,000	Orange, N. J.		Windsor, Ont.	
power boilers	30,000	Orange County, Cal.		Winston-Salem, N. C.	
		Paducah, Ky.		Zanesville, Ohio	
		(McCracken County)			

(A blank listing signifies that the Smoke Abatement Ordinance referred to does not establish a maximum rate of heat release)

2 MAXIMUM HEAT RELEASE RATES permitted for oil fired boilers vary in different cities

17 to 1 for net load is equivalent to 1.8 hp output per 10 sq ft boiler heating surface, or 80 percent overload.

But the larger series of boilers get a *gross* output rating of 17 to 1, which translates over to 1.21 hp per 10 sq ft, or 21 percent overload. The reason for running a small boiler at higher overload than a larger size is obscure. Furthermore, the second or larger series starts with 129 sq ft of heating surface, with the result that between 129 sq ft and 177 sq ft, two methods of rating prevailed through 1953.

But in 1954 the SBI issued a new Code which extends the 17 to 1 ratio on *net* load to boilers up to 294 sq ft heating surface, and refers to this series merely as Table 2 boilers. The former series of commercial sizes, now designated merely as Table 1 boilers, remain as before, which means that the range of areas overlaps no longer.

The reason for imposing heavier loads on smaller sizes than on larger sizes still remains obscure, but the reason for confusion in the SBI can be ascribed to the competition from package boilers. The latter are rated, usually, at maximum, and on the basis of 5 sq ft or less per boiler hp, or 2 hp or more per 10 sq ft of heating surface. The SBI now is permitting more generous ratings, but only in smaller sizes. However, some members of the SBI are now publishing ratings in special bulletins, not identified with SBI, which are more liberal.

The SBI Code stipulates a minimum combustion volume based upon a heat release rate of about 45,000 Btu per cu ft per hr. Curiously, practically every member manufacturer fails to show an adequate setting for either oil or stoker firing. Current catalogs show a base height of about 15 in. — a carryover from the days of hand firing.

Test-Rate Cast Iron Boilers

For cast iron boilers, we find a somewhat different basis of rating. Whereas under SBI, steel boilers are rated entirely on the basis of heating surface, cast iron boilers are rated — by the Institute of Boiler and Radiator Manufacturing — by actual test. Of a given series of boilers having identical cross section and varying only in number of sections, the IBR Code requires that at least the smallest and the largest be tested under prescribed conditions. However, should the design of intermediate sizes introduce change in cross section — by the use of or omission of crossover, uptake, bridgewall, curtain sections, baffles, etc. — the Code requires that these sizes be tested also. The Code test calls for minimum performance as to CO_2, draft loss, and stack temperature. The Code sets up deductions from gross output to allow for piping and pickup loss.

The IBR Code for cast iron boilers, oil fired, establishes a maximum heat release rate of 80,000 Btu per cu ft per hr. Even this restriction is waived in the case of factory assembled boilers with firebox and burner integral, upon submission of satisfactory performance data.

As with steel boilers, manufacturers of cast iron boilers continue to publish catalog dimensions showing hand fired settings, failing to inform of the higher setting required for mechanical firing. It might be argued for the makers of steel and cast iron boilers that, not knowing what equipment will be used for firing, they cannot show the particular requirement for setting height, and furthermore, that many of the larger sizes are purchased for jobs where the specifications have been drawn by consulting engineers. But I do not feel that this attitude supports the procedure.

Nevertheless, the SBI and the IBR Codes have accomplished much good. Before their establishment, rating practice was chaotic.

The steel boiler manufacturers, although currently revising their rating practice, have been conservative.

Abstracted from a paper presented at the recent annual meeting of the Air Pollution Control Association.

Another article by the author on this subject will be published in a future issue. It will cover draft control and smoke control codes.

1 SNOW MELTING by a heated fluid circulating through embedded piping panels keeps pavements free of snow and ice. Serving ramps, runways, sidewalks, playgrounds, and other surfaces, systems eliminate hazards to vehicles and pedestrians and keep facilities ready for use in all weather. [Photo courtesy of Plumbing and Heating Industries Bureau]

Are Thermal Stresses a Problem in Snow Melting Systems?

By William P. Chapman

Engineering Sales Service Representative
National Tube Div., U. S. Steel Co.

—Yes. They can be avoided by keeping the temperature difference between the fluid and the slab surface to a minimum, by providing a 2 in. pipe bury in the concrete, and by installing reinforcing steel above and below the piping where high structural loads are anticipated. This article concluding the analysis of thermal stresses, explains why pipe length can be ignored, why tangential stress is worse than radial or longitudinal, and why a 2 in. bury is best. Discussed also are the linear effect of temperature drop, the interrelationships of interdependent variables, and the effect of pipe diameter on temperature.

"The real problem lies in the ability of the concrete to withstand tensile stress. Pipe stresses are far below the allowable limit."

SINCE AN EXPANSION in one direction causes a contraction in another, there would be a greater axial stress if the radial and tangential stresses were zero. Using some magical material that allows longitudinal stresses only:

$$u_p = l_p A_p \Delta t_p \quad \ldots\ldots\ldots\ldots\ldots\ldots [6]$$

where Δt_p = temperature rise in the pipe; u_p = displacement of pipe, in.; l_p = length of pipe, in.; A_p = coefficient of thermal expansion for pipe, linear, in. per in.

and also

$$u_c = l_c A_c \Delta t_c \quad \ldots\ldots\ldots\ldots\ldots\ldots [7]$$

where u_c = displacement of concrete, in.; l_c = length of concrete, in.; A_c = coefficient of thermal expansion for concrete, linear, in. per in.; and Δt_c = temperature rise in the concrete.

Since the pipe and concrete are bonded together, all stresses will be transferred from the pipe to the concrete or vice versa.

From Hooke's Law

$$s/e = E \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

but

$$e = u_c/l_c = u_p/l_p \quad \ldots\ldots\ldots\ldots\ldots\ldots [8]$$

since

$$l_c = l_p \quad \ldots\ldots\ldots\ldots\ldots\ldots [9]$$

and

$$u_p = u_c \quad \ldots\ldots\ldots\ldots\ldots\ldots [10]$$

(because of perfect bond).

And since

$$s = eE \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

then

$$s_c = U_c E_c / l_c \quad \ldots\ldots\ldots\ldots\ldots\ldots [11]$$

and

$$s_p = U_p E_p / l_p \quad \ldots\ldots\ldots\ldots\ldots\ldots [12]$$

Also from Equation 7

$$s_c = l_c A_c \Delta t_c E_c / l_c \quad \ldots\ldots\ldots\ldots\ldots\ldots [13]$$
$$= A_c \Delta t_c E_c$$

or from Equation 6

$$s_p = l_p A_p \Delta t_p E_p / l_p$$
$$= A_p \Delta t_p E_p \quad \ldots\ldots\ldots\ldots\ldots\ldots [14]$$

In either case, notice that l drops out. This is because both longitudinal stress and strain are unit functions, and so is the coefficient of expansion. In other words, length does not affect thermal stress.

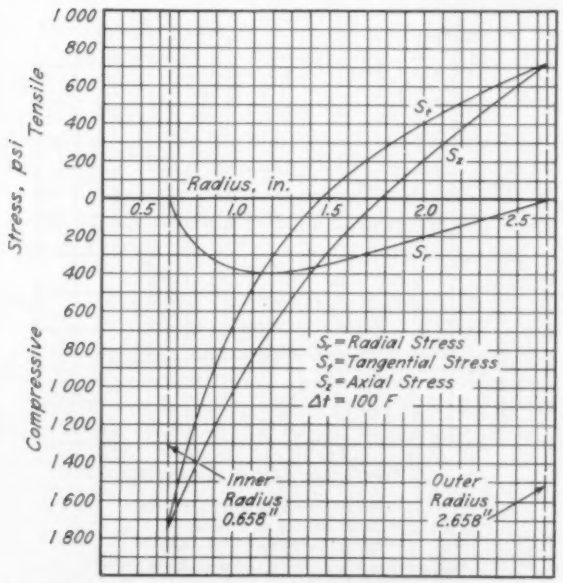
Tangential Stress Is Worst

The stress caused by the difference in expansion is of chief interest. The expansion itself is taken care of by the expansion joint in the concrete. But there can be identical stresses for an infinite number of lengths because the thermal expansion depends upon length directly, while strain depends upon length inversely.

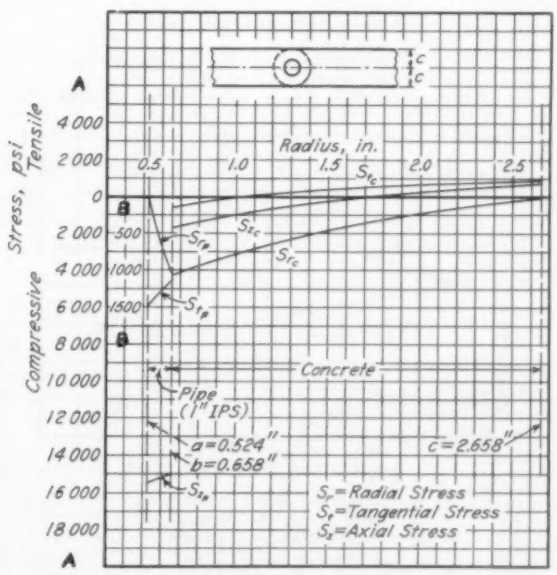
Failure may be caused in two ways. First, the combined stresses may exceed the allowable fiber stresses of either the pipe or the concrete. Second, there may be relative movement between the pipe and the concrete. Of the two, only the first is of practical importance. The real problem lies in the ability of the concrete to withstand tensile stresses. Pipe stresses are far below the allowable limit.

Actually, concrete is not a truly elastic material; it shows signs of plastic deformation. But in structural calculations it is considered safe practice to assume it elastic for tensile stresses up to 10 percent of its compressive strength. That is, the allowable fiber stress in tension may be taken as 300 psi if the compressive strength is 3000 psi.

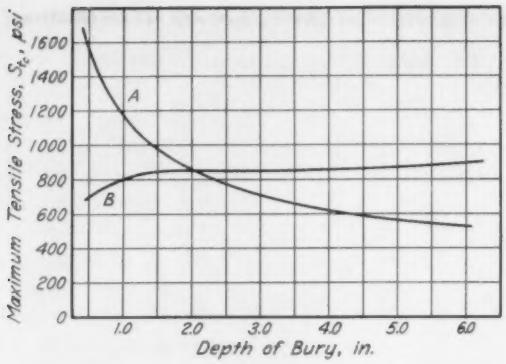
Since the compressive strength of concrete is considerably greater than the tensile strength, failures follow the "maximum stress law." That is,



2 THERMAL STRESSES in a circular homogeneous concrete cylinder represent a special case, inasmuch as there are no induced stresses as in a composite cylinder. When $s_z=0$, $s_r=s_t$. Also, when $s_t=0$, $s_r=s_z$



3 RESTRICTED PIPE ENDS result in high tensile stresses in the concrete, as shown in this graphical representation of the three stresses, s_r, s_z, and s_t, for a typical panel-slab. (For values of s_{rc} use Scale B; for others use Scale A)



Curve A is for constant value of $t_a - t_c = 100$ F. Curve B is for corrected values of $t_a - t_c$ to allow for effect of depth of bury.

4 DEPTH OF BURY should be 2 in. for quick response and minimum tensile stress, as shown by Curve B

the greatest stress generally accounts for the failure. This study indicates that the maximum tensile stress in the composite cylinder occurs at $r = c$ and is the tangential stress. We may say then that this is the critical stress and the one governing failure. The tangential stresses at $r = c$ are shown in Table 1 for various pipe sizes.

2 In. Bury Seems Best

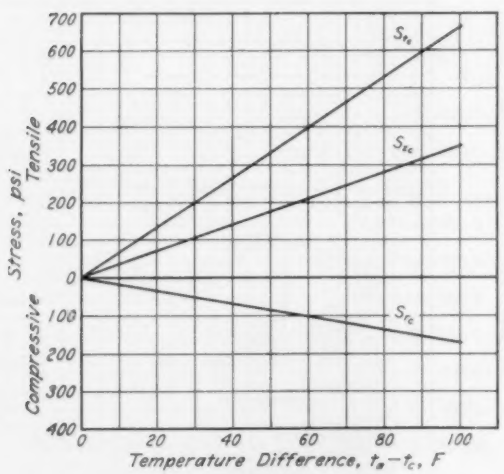
The effect of depth of bury on the maximum tensile stress, s_{tc}, is shown in Fig. 4. Curve A is for the constant temperature difference of $t_a - t_c = 100$ F. Curve B represents s_{tc} for various values of $t_a - t_c$. These values of $\triangle t$ represent the temperature difference to be expected for an output of 200 Btu per hr per ft of pipe length for the various depths of bury. The value of $\triangle t$ may be determined from data given in *Heat Flow Analysis in Panel Heating or Cooling Sections*, by L. E. Hulbert, et al, ASHVE Journal Section, HPAC, April 1950, pp. 117 — 122.

In actual practice it must be remembered that depth of bury will affect temperature difference as well as thermal stress, because of an effect on the thermal resistance of the slab, R. It is necessary then to consider both variables simultaneously. Curve B is of greater practical importance. This curve indicates that a cover varying from 1½ to 4 in. will give approximately the same tangential stresses. The size of the aggregate usually makes it impractical to specify a cover of less than 1½ in. Therefore, to assure quick response and minimum stress, 2 in. seems best.

Temperature Drop Effect Linear

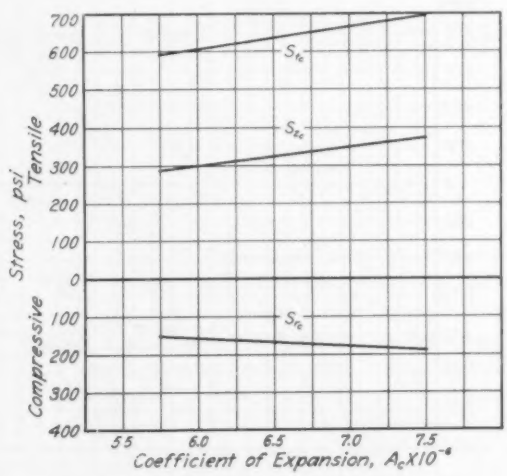
The thermal stresses are directly proportional to temperature difference. This is shown in Fig. 5 for the general case of the composite cylinder.

For the homogeneous cylinder $t_a - t_c$ represents the temperature drop through the concrete. For the composite cylinder, however, $t_b - t_c$ represents the temperature drop through the concrete; the term $t_a - t_c$ represents the total temperature drop, including that through the pipe wall.



S_{tt} = Tangential Stress in Concrete
S_{ta} = Axial Stress in Concrete
S_{tr} = Radial Stress in Concrete
All stresses for $r = 2.158''$

5 THE THERMAL STRESSES in concrete — radial, tangential, and axial — are directly proportional to the temperature difference between pipe and concrete, as shown here for a slab with restricted pipe ends



S_{tt} = Tangential Stress In Concrete
S_{ta} = Axial Stress in Concrete
S_{tr} = Radial Stress in Concrete
Radius = 2.158", $t_a - t_c = 100$ F and $A_p = 6.5 X 10^{-6}$

6 THE RATE OF EXPANSION — shown here for pipe with restricted ends — has a directly proportional effect on the three thermal stresses

The radius of $r = 2.158$ in. was used in Fig. 5 so that the effect of $\triangle t$ on s_{rc} could be shown. If $r = c$ had been used, then $s_{rc} = 0$ for all values of $\triangle t$, but s_{tc} and s_{zc}, would have been directly proportional to $\triangle t$, just as in Fig. 5.

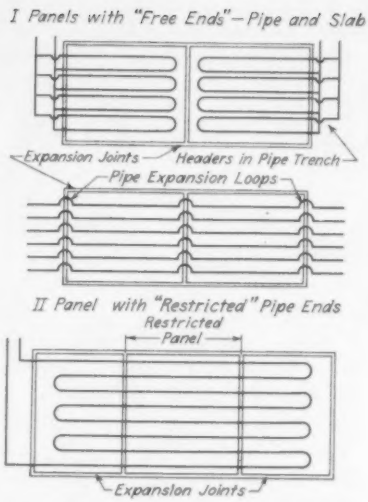
Consider Independent Variables

Each of the independent variables, A, E, and N, considered alone, produces a directly proportional effect on the radial and tangential stresses when $r \neq c$, and on the tangential stress at any radius. The axial stress s_{zc} is independent of changes in A_p, E_p and N_p.

Not only are the axial and radial stresses at $r = c$ independent of the induced stresses set up by the pipe, but it can actually be shown that at any radius the axial stress is independent of changes in A_p, E_p or N_p.

Each of the three independent variables, A_c, E_c and N_c, produces a directly proportional effect on all three stresses. The effect of A_c on the three stresses, s_{rc}, s_{tc} and s_{zc} is illustrated in Fig. 6 and is typical of the curves that could have been drawn for E_c and N_c.

Both A_c and A_p affect s_{tc}, and the difference $A_p - A_c$ or $A_c - A_p$ is not important. It is often mentioned that since concrete and common pipe materials have similar coefficients of expansion, there are only slight stresses caused by expansion. But the fallacy of judging the stresses by differences of coefficients is illustrated in Table 2.



7 DIFFERENT TYPES OF PANELS shown here produce little practical difference in stresses

Compute Stresses Directly

The linear variations discussed have been for one variable taken at a time while the other five remain fixed. When two or more variables are taken simultaneously, it becomes difficult to predict the change. Therefore, it is easier to compute the stresses directly than to apply any difference factors. The variation in stresses with regards to the independent variables is a function of the radii a, b and c.

Diameter Affects Temperature

The effect of pipe diameter can be seen in Table 1. While $t_a - t_c$ was taken as 100 F, this condition might not exist in an actual panel operating under field conditions. The main reason is that pipe size affects R_c and R affects the temperature difference $t_a - t_c$. Also, pipe of 1½ in. and 2 in. IPS would not be used for panels but for headers. For equal values of $\triangle t$, the use of smaller pipe sizes results in lower tensile stresses in the concrete, as indicated in Table 1.

Pipe Ends of Slight Effect

Two end conditions may be assumed: (1) restricted pipe ends and (2) free pipe ends. Restricted ends — see Fig. 7 — lead to slightly higher tensile stresses. (See Table 1.) The complication in construction to provide "free end" panels may not be worth the slight reduction in stress. In addition, expansion loops may set up certain stress concentrations that exceed — in a localized area — the savings to be expected. In short, there is little practical difference in the stresses obtained from the panels in Fig. 7.

Future Experiments Are Needed

There is still a considerable amount that should be studied regarding thermal stress. Future study, however, should be based on experimental results and take into account the plastic deformation of concrete. The present study could consider only the elastic properties. Also needed are refinements to allow for eccentric loadings due to headers and variable back losses. Theory alone will not give such answers, but it has pointed to a few precautions.

TABLE 1—MAXIMUM TANGENTIAL STRESSES — which generally account for the failures in composite cylinders of concrete and pipe — are shown here for various concrete cylinders with different pipe sizes for $t_a - t_c = 100$ F

Embedded Pipe	Radii, in., as shown in Fig. 2. a	b	c	Maximum Stress, s_{tc}[2], psi Case I[2]	Case II[3]
No pipe (Hollow concrete)	0.658	—	2.658	724[4]	—
¼ in. Steel pipe	0.412	0.525	2.525	752	780
1 in. Steel pipe	0.524	0.658	2.658	829	862
1¼ in. Steel pipe	0.690	0.830	2.830	910	952
1½ in. Steel pipe	0.805	0.950	2.950	957	1010
2 in. Steel pipe	1.034	1.188	3.188	1040	1105
1 in. Wrought iron	0.524	0.658	2.658	830	866
¾ in. Nominal type L Copper	0.373	0.438	2.438	699	728
¾ in. Nominal Aluminum[5]	0.373	0.438	2.438	707	740

[1]Maximum stress is for $t_a - t_c = 100$ F and is found at $r = c$ for tangential stress.
[2]For construction wherein "free" pipe ends are found, see Fig. 7.
[3]For construction wherein "restricted" pipe ends are found, see Fig. 7.
[4]For the hollow cylinder, a "free end" condition was assumed.
[5]Dimensions identical to ¾ in. nominal copper.

TABLE 2—COEFFICIENTS OF EXPANSION for common pipe materials and concrete (A_p and A_c, respectively) illustrate the fallacy of judging tangential stresses (s_{tc}) by differences of coefficients

A_p	A_c	$A_p - A_c$	s_{tc}[2], psi
6.5×10^{-6}	6.5×10^{-6}	0	634
7.0×10^{-6}	7.0×10^{-6}	0	683
6.5×10^{-6}	6.0×10^{-6}	0.5×10^{-6}	605
6.0×10^{-6}	7.0×10^{-6}	-1.0×10^{-6}	644

[1]At $\Delta t = 100$ F for conditions shown in Fig. 3.

QUESTION OF THE MONTH

How Can Heating Fuel Be Saved?

THE QUESTION, *What's the Best Way To Save Heating Fuel?*, was published previously in HPAC and is repeated here for information, with two of several answers that have been received from HPAC's readers. Other comments for publication will also be welcome.

"There are many things that can be done to save fuel required for building heating, but I wonder if it is possible to say what the one most effective method of heating fuel conservation would be? I'd be interested in any comments from readers as to what management of the 'average' small industrial plant or commercial building should look for when the possibilities of fuel conservation are being considered."

SALVATORE S. GUZZARDI —

"Install Temperature Controls, Time Clocks"

THE MOST EFFECTIVE method of reducing fuel heating cost is to install temperature controls and time clocks. We recommend the use of outdoor temperature control to reduce the steam supply and pressure as the outdoor temperature rises. If hot water is the heating medium, the the outdoor temperature control would reduce the water temperature as the outdoor temperature rises, since the use of hot water is based on continuous operation. One outdoor control is generally sufficient for each large building. Within the building, or buildings, install zone room thermostats which would control the steam supply to a large area or floor. This zoned thermostat will serve to prevent overheating that particular area.

Seven-day time clocks should be installed, either at the boiler room or in the various zones, for reducing the temperature during the night or for completely shutting down the heat during non-business hours. For reduced night temperature, install a low limit night thermostat which would operate the heating system if the room temperature falls below the pre-set temperature.

Then, if steam radiators are used, calculate the heat loss for each room or area and install properly sized orifices in each radiator. This would tend to balance the heating and provide uniform heating throughout the building. Where overheating still occurs, reduce the orifice size. Where underheating still occurs, check to determine the cause.

Consider reducing infiltration and adding wall insulation. Check the radiator thermostatic valve to determine if it is restricting condensate load.

Consider installing additional radiation in the underheated area or increasing the orifice size to provide greater heat into this area. In general, do not increase the steam supply or steam pressure or water temperature, and thus overheat the entire building, for the purpose of satisfying some small underheated area. This is a common mistake which results in considerable fuel waste.

Be sure that the steam distribution piping from the boiler room to the heating system is insulated. All of the condensate should be collected and sent back to the boiler room. A condensate pump, in which the condensate flows by gravity to the pump, will perform excellently. In the boiler room, we recommend installing a steam flow meter to measure all the steam generated by the boilers and to install a fuel oil meter, if oil is the fuel, possibly on the supply and return, to measure all the fuel used in the boiler room. This will permit determination of the average daily boiler efficiency.

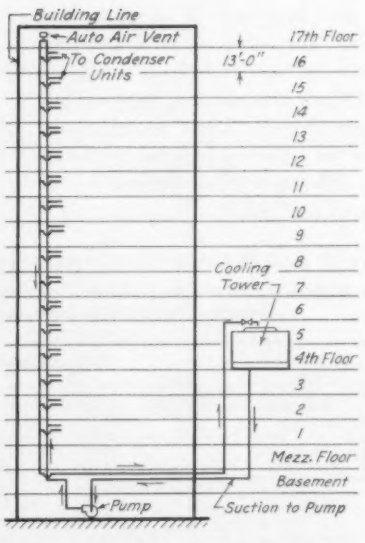
If the boiler efficiency is below 70 percent then check the CO_2 in the flue gas. It is also suggested that the flue gas temperature and the cleanliness of the heating boiler surfaces be checked.

READER ASKS —

"What Is Pump Head for Cooling Tower Piping?"

"I have a problem of accurately determining the pump head for the piping system where cooling water is pumped from a sub-basement to condenser units on all of 16 stories and then to a cooling tower which has the water inlet on the fifth story level. See the attached sketch.

I would appreciate any suggestions that others may have on how this problem may be solved."—J.A.W.



• *YOU ARE INVITED to contribute a question for publication, or an answer to a published question. Please address your reply to the Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.*

Check the economics of using heavier oil, or gas, or different coal. For example, suppose that No. 2 oil costs 13c per gal, No. 5 oil costs 8c, and No. 6 oil is 6c per gal. If No. 6 oil can be substituted for No. 5, the fuel cost reduction is 25 percent.

From the steam flow meter, check the rate of steam output versus the boiler rating.

If the steam output is below 25 percent of the maximum boiler steam output, then the efficiency is generally very low. In that case, consider the economics of installing a properly sized boiler.

If possible, the oil input to the burners should be modulated in accordance with the boiler pressure. An automatic draft control should be installed to shut off the draft, either at the bottom of the boiler or in the breeching, so that during shutdown of the burner there is no cold air drawn into the boilers.

Any steam exhausted to the atmosphere in any manner, either by flashing or from steam pump discharge, should be utilized to heat fresh boiler water make-up or domestic hot water, or utilized in the heating system.

An excellent detailed guide for reducing fuel consumption is the booklet, "Principles of Economical Heating," published by the National District Heating Association, 827 N. Euclid Ave., Pittsburgh 6.—SALVATORE S. GUZZARDI, Consulting Engineer.

JOHN BELUNAS —

"Save Heat with Adequate Control, Gas Analysis"

IN MY OPINION, one of the most effective methods of conserving heating fuel is by adequate boiler control. Controls do get out of adjustment. Because of this, many boilers are losing thousands of heating units. For one thing, they may start feeding too much air, and excess air reduces the temperature of the fire and carries a lot of heat up the stack. Or the controls may give too little air, and the flame becomes smoky, depositing soot on all heat transfer surfaces, reducing the effectiveness of these surfaces in absorbing radiant heat and letting a lot of heat escape up the stack.

I would recommend periodic flue gas analyses to make sure that combustion is as efficient as possible. In lieu of that, I would suggest that fuel consumption be checked against degree days. If there is a discrepancy in the fuel to degree day ratio, flue gas analysis is mandatory.—JOHN BELUNAS, Consulting Engineer.

ON THE JOB

Air Conditioning Unit Is on Bank Mezzanine

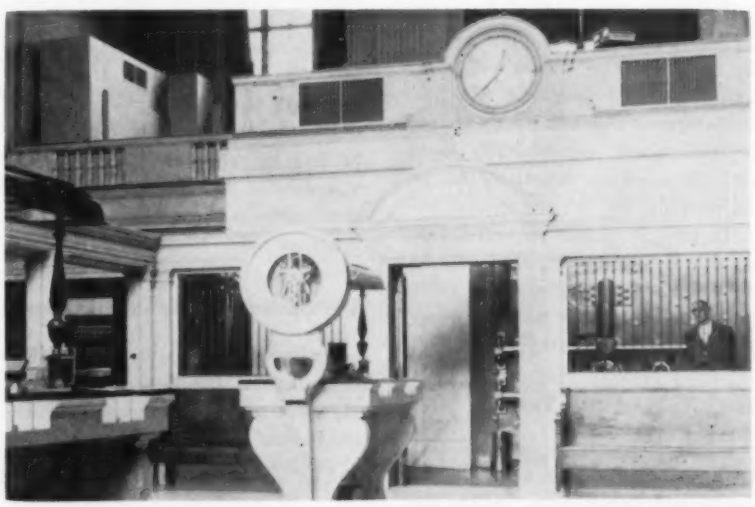
. . . three way bypass valve controls 28 ton system

TO SUPPLY CONDITIONED AIR to an open mezzanine, the main banking floor, and the enclosed directors room of the 60 × 100 ft office of the Virginia Trust Co., Richmond, the mezzanine, 15 ft above the main floor — which has a 50 ft high ceiling — was chosen for the location of the air conditioning unit, according to the Worthington Corp.

From this unit, which has a six row chilled water coil and high velocity filters, the main delivery duct turns downward and follows the balustrade at the floor. Balusters removed from the front of this railing permit two large supply outlets to serve the main banking area.

Supply to the directors room is through a second take-off from the plenum chamber by a duct running through a window and down the outside wall, with delivery through an outlet at the top of the directors room window.

Supply to the mezzanine is through an outlet on the face of the plenum chamber. The air volume is controlled by an acoustic lined plate, which is larger than the opening and which is adjustable.



CONDITIONED AIR from the unit on the mezzanine is supplied through an outlet on the plenum, outlets on the main duct along the balustrade, and through a take-off duct down the outside back wall to the directors room

A 28 ton water chiller is in the sub-basement. Circulating lines are installed on the outside back wall of the building. Control is by a modulating three way bypass valve, with the water at constant temperature.

SAM LEWIS' PAGE

Atomizing Liquid Fuels

. . . depends on size of the boiler, characteristics of the fuel, and other factors

PROPONENTS of different types of oil burners frequently clash. Recently my interest was invoked in an attempt to determine which of two proponents was most nearly correct when they disagreed on the method of atomizing the oil.

Fuel Is Semi-Fluid When Cold

The fuel in the particular plant in question is to be fluid when heated; but it is expected to be only semi-fluid, like cold molasses, at winter temperature. The fire intensity must be maintained automatically along with an adequate supply of air for combustion.

The steam output expected from the single boiler is 25,000 lb per hr. At the usual 200 percent of rating for a boiler of this size, the designation would be 360 hp.

Heat Transmitter Term Is Mb

I hate to overwork poor old Dobbin's horsepower, just as I hate the casual and sloppy term "square feet of radiation." I helped to start the use of the term Mb, meaning 1,000 Btu per hr. I still believe the expression "pounds of steam" is better than horsepower, and that the term Mb should be used for heat transmitters, no matter whether the substance that heats the transmitter is steam, a gas, or water, or some other liquid, or electricity.

The owner of a large air conditioning project insists, despite my protests, that the heat removal units be expressed in watts rather than in Mb. Again, I recognize a tendency to think, inaccurately, of a watt as 3 Btu per hr instead of 3.4 Btu per hr and to call a horsepower, as in a motor, an Mb instead of 746 Btu, thus allowing for frictional heat waste.

Use Steam Atomizing Oil Burner

Getting back to the oil atomization dispute, for this big boiler, I suggested a steam atomizing oil burner, feeling that the usual maximum of 2.5 lb of steam, expected to deliver and atomize a gallon of this sluggish fuel, will be justified. One of the burner men attempted to crush me with his assurance that this boiler must have a pressure atomizing, electrically whirled horizontal shaft, oil and air mixer. He swore that no other kind could be tolerated.

Another burner man was sure that neither the steam jets nor the rotary oil-air mixer would be acceptable but would stake his standing on a burner that is a combination of both types. The correct arrangements, of course, depend on many other factors, especially on the size of the boiler and on the characteristics of the fuel.

Heat No. 5 or Heavier Fuel Oil

I wish no further association with any No. 5 oil — or with any liquid fuel more difficult than No. 5 to transport and to atomize — unless it is heated before it reaches the burner.

If any boiler does not evaporate water into steam, but is expected merely to heat water, so that there will be no steam for atomizing, I would use pneumatic pressure atomization for the larger sizes, and rotary cup atomization for the smaller sizes. I might inject the air for combustion by means of a separate fan.

I remember the tendency on salty sea-going ships to conserve precious condensed water, and therefore to employ oil pressure atomization for oil burners. On land, the amount of steam required — at most 2.5 lb per gal of the heavy oil — is relatively inconsequential.

I like the ideas of the burner man who would combine either steam or air under pressure, with the oil under pressure, all automatically controlled as to proportions.

SAMUEL R. LEWIS, consulting mechanical engineer and a member of HPAC's board of consulting and contributing editors, comments informally each month on practical heating, piping and air conditioning problems.

ASRE Marks Research Developments

. . . at 42nd semi-annual meeting

• Several of the papers given at the semi-annual meeting of the American Society of Refrigerating Engineers, held recently in Milwaukee, proved to be of interest to HPAC readers. Abstracts of six of the papers are presented here.

1. Calculate New Properties for Refrigerant

GREATLY EXTENDED RANGES of refrigerant pressure and temperature have been calculated for "Freon 12" as a result of several years of research, conducted jointly by the Engineering Research Institute of the University of Michigan and the du Pont Co.'s Jackson and "Kinetic" laboratories. The paper was prepared by R. C. McHarness, research supervisor and Dr. B. J. Eiseman, Jr., research chemist, of the "Kinetic" Chemicals Div. of the E. I. du Pont de Nemours & Co., Inc., and Professor J. J. Martin, of the University of Michigan.

In the research study a total of 150,000 values were calculated. Of these, 40,000 are included in three saturation tables and 255 superheat tables, covering a temperature range of −150 F to +515 F and pressures from 0.14 to 588 psia. That range, with measurements accurate to 1 percent or better, "should meet all possible needs of the refrigeration and other industries" for many years, Mr. McHarness said. The original 1931 tables on "Freon-12" covered only the −40 F to +140 F range.

In several of the 14 charts the range is extended to 700 F and 5000 psia.

Greatest usefulness of the new data, aside from increased accuracy and consistency, will be in the sharply decreased amount of interpolation required when using existing technical data on "Freon-12" dichlorodifluoromethane to arrive at the operating temperatures and pressures in refrigeration equipment.

While the new data requires no major change in current design conditions, it will, by extending the range of previously available data, greatly simplify engineering and design work, as refrigeration equipment goes toward higher compressor pressures and temperatures.

Included in the new data — which du Pont's "Kinetic" Chemicals Div. is publishing in manual form — are 10 pressure-enthalpy charts, including one broad-range, a single-sheet refrigeration-range chart, and eight large-scale diagrams covering the refrigeration range; a single broad-range entropy-enthalpy diagram, and three graphs of specific heat data, broken down by constant pressure, constant volume, and the ratio of pressure to volume.

Three saturation tables present data in the form of even temperature values, even absolute pressure values, and gage pressure values, while 255 individual tables are included to provide superheat data. Among the latter, 129 tables are devoted to constant pressure for even values of saturation pressures, while the other tables deal with constant pressure for odd values of saturation temperatures.

The new computations represent the first major revision of thermodynamic data on "Freon-12" in the 24 years since it was first marketed in 1931.

2. Moisture Content Varies with System

IN THE PAPER, "Moisture Migration in Hermetic Refrigeration Systems as Measured Under Various Operating Conditions," W. R. Brisken, manager of advance engineering, Commercial and Industrial Air Conditioning Dept., General Electric Co., arrived at four conclusions. These are:

1) The moisture content of the refrigerant in an operating system in which the rate of turnover of the charge is high is the same for the liquid and vapor phases after equilibrium has been established.

2) Refrigeration systems charged with "Freon 12" and "Freon 22" have greatly differing moisture characteristics.

3) Moisture migration calls attention to acid migration, which is considered a cause for decomposition of cellulose in motor insulation, and for increasing the moisture content in the system.

4) Increasing moisture content with time under comparable operating conditions should be considered as an indication of progressing deterioration in a refrigeration system.

The charge of a refrigeration system consists of a variety of substances, such as the refrigerant, lubricating oil, and small amounts of impurities, one of which is moisture. This charge is exposed to, and in contact with, numerous different metals and perhaps their oxides, and organic materials, such as the shaft seal in an open refrigeration unit or the motor electrical insulation in a hermetic unit.

This complex situation is further aggravated through great temperature differences at various points in the system. The safe moisture limit will depend greatly on the design and operating conditions of the type of unit. It is difficult to give one single answer to this problem.

Refrigeration systems charged with "Freon-12" and with "Freon-22" show transient moisture conditions for some time after startup and shutdown of the systems. As could be expected from the differing moisture equilibria between liquid and vapor phases of the two refrigerants, the changes of moisture content as functions of operating time are greatly different.

The transient periods are also longer for systems charged with "Freon-22" than for those charged with "Freon-12". During operation and after the transient period, moisture content in the refrigerant is uniform and independent of phase. This simplifies testing, inasmuch as any convenient point in the system can be selected for sampling.

Moisture was also measured as a function of the winding temperature of the electric motor. Various basic moisture contents were produced artificially by adding water to the systems. It was observed that most of the water in a unit is contained in parts of the system other than the refrigerant and oil. From this data, a chart was developed which permits reading the total moisture in a refrigeration system from a single moisture test under specific conditions.

3. Suggest Fan—Motor Vibration Control

THE CONTROL of vibration from rotary systems, particularly fan-motor combinations, was discussed in the paper, "Vibration and Vibration Analysis of Commercial Units," by C. A. Hathaway, chief engineer, and K. A. Merz, engineer in charge of product development, Torrington Mfg. Co.

Vibration analysis of prototypes of air handling units is advocated before they are put into production. Neglect to analyze vibration raises production and servicing costs and causes customer dissatisfaction by requiring special balancing tolerances and other expedients, which are deranged by dirt accumulation and field installation and handling.

The authors derived an equation which relates the amplitude of vibration to rotor unbalance speed, and natural frequency of the system. The commonest cause of vibration trouble is operation near resonance.

4. Air Condition Farm Animals

BENEFICIAL EFFECTS of air conditioning upon farm animals were reported in the paper, "Physiological Effects of Environment on Domestic Animals," by H. L. Garver, agricultural engineer, U. S. Dept. of Agriculture.

Several large climatic chambers have been built for the study of small farm animals, but the number of such chambers suitable for large animals now being used is few. There are now a half-dozen or more for cows. These climatic chambers are designed for operation at controlled temperature, moisture, and air movement from zero F to over 100 F, with relative humidities ranging from less than 50 to around 100 percent, according to Dr. Garver.

The Psychroenergetic Laboratory at the University of Missouri is equipped with about 35 tons of refrigerating capacity. The poultry calorimeters require a capacity of about 5 tons.

Since under most conditions, farm animals — particularly cows and swine — produce a large amount of heat, the heating requirements necessary to maintain high temperatures are usually low.

The purpose of most climatic laboratories for investigating farm animals is to determine the most effective housing conditions for maintaining health and high production, as well as to promote growth. Attempts are also being made to discover whether or not temperature has any any effect upon reproductiveness of farm animals.

It has been learned that under environmental conditions, feed consumption for a given rate of production or growth can be kept to a minimum. Agricultural engineers are interested primarily because the design of shelters is influenced by the conditions that should be maintained. Since buildings are part of the cost of a farming enterprise, they must eventually pay for themselves.

Mr. Garver said that the outlook and potential for the air conditioning industry in the agricultural field looks very promising.

5. Improve Rotary Compressor

IN THE PAPER, "Characteristics and Performance of Rotary Compressors," H. F. Lehmkuhl, manager of compressor development, Seeger Refrigerator Co., pointed out that when the rotary compressor was first introduced, it offered advantages of smaller size, less weight, fewer parts, direct drive, higher speed, inherently balanced smooth running parts, and potentially improved performance.

Initially, the operating efficiency of the rotary compressor was low, as compared with comparable reciprocating compressors already in use. Since that time, compressor efficiency in the rotary has been improved more than 100 percent. During the same period of time, improvement in the reciprocating machine has been less marked.

Some of the comparisons that are made between the characteristics of rotary and reciprocating compressors, including the design factors, are listed below. Recent actual test data was used in the following improvements and developments:

1) Higher volumetric efficiency.
2) Higher performance coefficient.
3) Higher favorable load factor.
4) Higher power factor.
5) Higher usage of motor ability.
6) High side crankcase.
7) Higher speed operation.
8) Inherent balance.
9) Reduced size.
10) Lower weight.
11) Lower noise level.
12) Greater life expectancy.

Charts were also developed which showed how rotary compressors may be employed to improve performance characteristics of air conditioners and other applications.

6. Study Injection Refrigeration

REPORTED in the paper, "The Injection Refrigeration Cycle," by Dr. W. M. Carter, professor of machine design at the University of Kentucky, experimental results at the University of Michigan with a special rotary compressor well adapted for the injection refrigerating cycle indicate that practical performance gains are possible.

A discussion of the thermodynamic relationships in refrigeration cycles, with reference to the injection cycle, was presented, and the factors affecting the coefficient of performance were given. Equations for calculating this coefficient for the injection cycle were also developed.

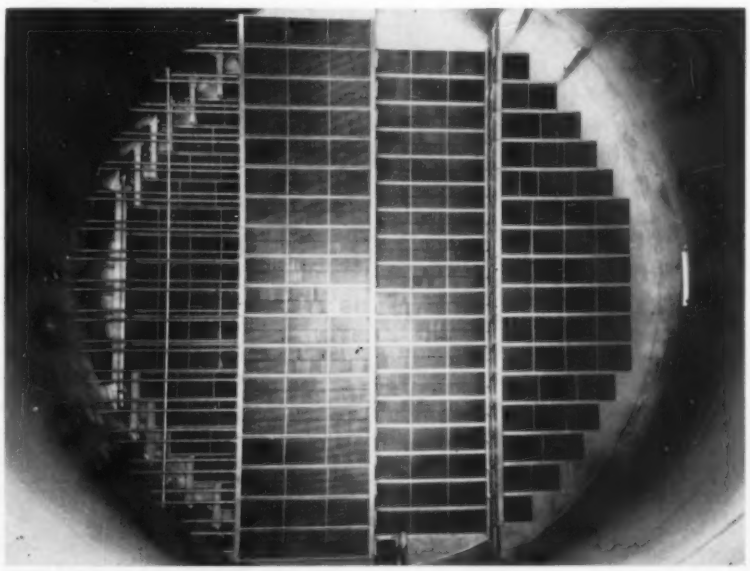
An injection nozzle, which is pressure operated and suitable for commercial compressors, has been designed and is being adapted to a standard compressor at the University of Kentucky.

Big Coil Bank Aftercooler Installed in Wind Tunnel

. . . for aeronautical research

ENORMOUS BANKS of water coils such as this one installed in the Ames unitary plan wind tunnel are used to control the temperature of air circulating through a supersonic wind tunnel, according to The Trane Co. Compressing the air to drive it around the tunnel circuit raises its temperature, but all of the heat must be removed as it passes over these water cooled coils.

When everything in the tunnel is operating at top speed, 54,000 gal of water will pass through these coils each minute. The size of the 70 ft diameter of the aftercooler shell pictured here is apparent from the size of the man at the bottom. The largest coil unit mounted in this bank is 16 ft long and 40 in. high.



The tunnel using this aftercooler is the newest supersonic research facility being built at the Ames Aeronautical Laboratory, which the National Advisory Committee for Aeronautics operates at Moffett Field, Calif.

PRACTICAL PIPING PROBLEMS

By Bill Dopp

If there's any secret, says Mac, it's preventive maintenance, as he tries to show his friend how to . . .

Prevent Those Piping Leaks

When leaking stuffing boxes and a leaking globe valve in a steam line operating an ash conveyor force the maintenance engineer to work on Sundays, Mac traces the trouble to a violation of one of his first principles of engineering: "A gate valve should be installed at the header on every branch line so that the smaller lines can be serviced without shutting down the whole plant."

Besides the gate valve, he recommends here a hammer blow chainwheel, for easier closing of the globe valve, and a serious program of preventive maintenance.

CLINT BOLBY, maintenance superintendent of the Products Packing Co., threw the phone into its cradle. "Will some people never understand?" he exclaimed.

"Never understand what?" asked a voice behind him. Martin MacVane, gasket salesman, stood grinning in the doorway as Clint swung around. Clint glared at him for a moment.

"Oh! it's you," he said, his face struggling into a smile. "Come on in, Mac. Find yourself a seat."

"Your blood pressure seems to be up, Clint. What's it all about?"

"I'm in the doghouse again," said Clint. "My wife wants to go somewhere Sunday, and I've got to work. She just won't understand that I don't work on Sunday because I like it. I talk my head off, but she won't believe that there are things that can't be done at any other time."

Looking at the dejected figure, Mac couldn't resist the temptation to needle his friend. "Maybe she's right," he said.

Valve and Stuffing Boxes Leak

"What do you mean, she's right?" Clint shouted. "Look, that valve on the ash conveyor is leaking so badly again that if we don't fix it, we won't have any steam. There are a dozen leaking stuffing boxes, thanks to poor packing, and a couple of pipe joints have gone to pot." He made a sweeping gesture. "None of this can be fixed while the plant is running. We can't even do it at night during the week."

"Calm down," soothed Mac. "Did you ever hear of preventive maintenance?"

"Mac, don't lecture me now," pleaded the harrassed engineer. "Yes, I've heard of it. But what can you do in an old plant like this, where everything is worked to death?"

"You can use your head, Clint. Take those leaking stuffing boxes, for instance. There just is no excuse for a leaking stuffing box. Period! No matter how poor the packing, if it is properly followed up, it will serve an incredibly long time."

"What do you want me to do, tighten up a thousand stuffing boxes every day? Use sense, Mac." Clint turned toward the ringing phone indignantly.

When he put the phone down, Mac was laughing. "Here, smoke a cigar and listen to me." He handed a cigar across the desk. "Let me tell you what a friend of mine did a few years ago," he said.

"This fellow had the same problem that you've got. But he finally got tired of wrestling with it. He had an old man in his crew who couldn't do heavy work, so Jack gave him the title of piping inspector and a kit of tools. You should have seen how proud the old boy was."

Mac continued, "They worked out a route together so that every foot of piping and every valve in the plant gets a careful look at least once a week. The slightest hint of a steam flag on a valve or a spot on a pipe joint and the piping inspector goes to work. If he can't do the job himself, he gets help. But nothing is allowed to go more than a few hours."

Bill Dopp has had some 40 years of experience dealing with piping, including a long stretch as a sales engineer. He is devoting part of his present leisure to writing of his many piping experiences. All the names used are fictitious.

"Do you mean to say that he has someone on his payroll who does nothing but walk around and look at piping? I should sell that one to my management!" Clint laughed aloud.

Savings Exceed Wages

"That man's wages can come out of savings several times," said Mac. "What does it cost you to keep a crew working nights or Sundays — time and a half or double time? I'd like to have as a salary what you can save in this plant by a proper setup of preventive maintenance. In Jack's plant the only time they work on Sunday is when they take a boiler out for overhauling."

"That might be all right in a fancy power plant" declared Clint. "But it won't work around here, where these huskies abuse valves unmercifully. They stick a pipe into the handwheels to close valves, bend stems, leave valves cracked open for long periods, and generally do everything they can to make work for us." He shook his head derisively. "No, Mac, your idea is not for us. We're just common people."

"It's just a suggestion, Clint." Mac sat silent while Clint made a phone call.

Then he asked, "What about that ash conveyor valve? You said it was leaking again. How come?"

Steam Line Globe Valve Leaks

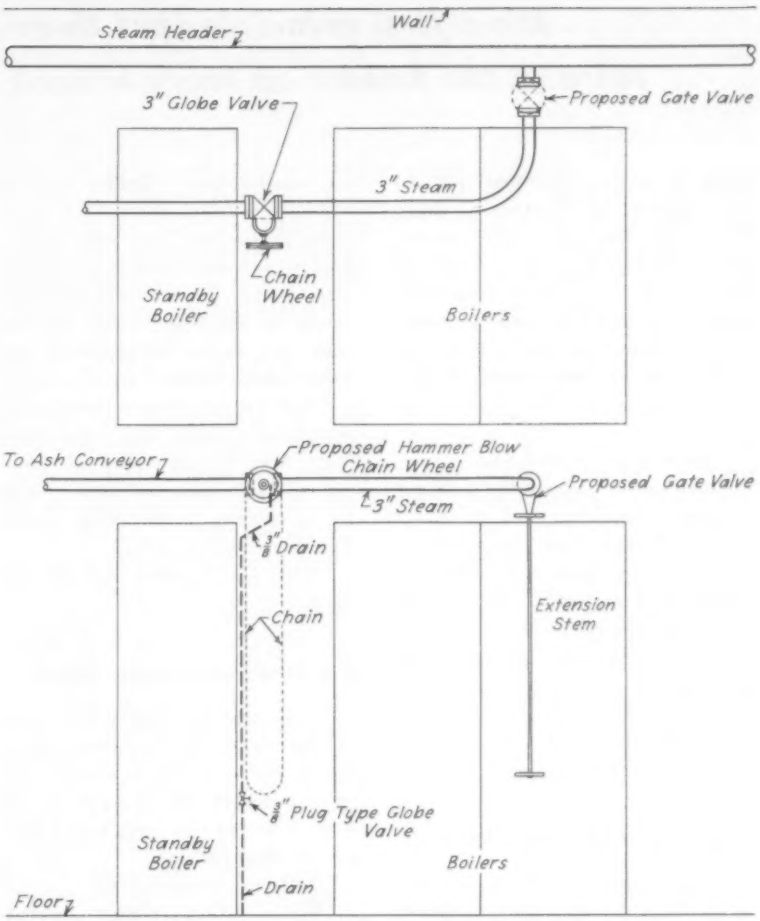
"That's a 3 in. globe valve in the steam line to the ash conveyor. We blow the ashes out of the boiler hoppers two or three times a day to discharge them into the outside silo. The system works fine except that the globe valve gets to leaking so badly every three or four months that we have to lap it in. It's up so high above the boiler room floor, we have to take it out of the line to do the job."

Clint shrugged his shoulders. "That means banking the big boilers and firing up the standby kettle. It's a tough job, and it has to be done on a Sunday. Takes all day, too."

"Maybe I'm dumb, Clint, but something in your description sounds screwy to me. Let's go down to the boiler room and take a look at the layout. I just don't see why you have to shut down a couple of boilers to repair a little globe valve."

"Well, I guess it's easier to show you than to explain it. Come on, let's go," said Clint.

"Do your boiler room operators abuse valves, too?" asked Mac, as they made their way down to the lower floor.



PROPOSED GATE VALVE, when installed at the steam header, will enable servicing the 3 in. globe valve in the 3 in. steam line without shutting down the plant

Seat and Disc Are Badly Cut

"No," laughed Clint, amused at the way Mac put the question. "Those boys are real operators. It's not abuse that makes this valve leak. Darned if I know what it is." He pointed to a valve with the stem horizontal in a line at least 20 ft above the floor, that passed over the aisle between the boilers. It was equipped with a chainwheel, the chain hanging looped over a hook on the side of the boiler.

"Harry, over there," said Clint, pointing to the operators, "weighs over 250 lb, and he can't close that baby by hanging his whole weight on that chain. The seat and disc are both badly cut, I'll bet."

Mac walked around to the rear of the boilers, squinting to get a look at the line. "Is that the line up there?" he asked, pointing. "Where's the gate valve?"

No Gate Valve Installed

"There's no gate valve on that line," admitted Clint. "The head

". . . It's a first principle that there should be a gate valve at the header on every branch line."

room is so low that they put all the nozzles on the main steam header on the side. You couldn't get a chain wheel on a valve up there, even if it were horizontal. That's why they left it out, I guess."

"How far is it from the header to that leaking valve, about 15 ft?" asked Mac, eyeing the lines disapprovingly.

"About that," replied Clint.

"Line slopes toward the valve, I suppose," said Mac.

"Sure," said Clint, frowning.

"And your gage says 150 psi. Saturated, I presume?" Mac looked up at the lone globe valve.

"Yes, — sure it's saturated. All the steam here is for processing and heating." Clint watched Mac narrowly, as though he could sense something coming his way.

Condensed Steam Cuts Valve

"Fine," declared Mac sarcastically. "You let the steam condense in that nice dead end line while the valve is closed; and when they start to open it, that hot water does a fine job of cutting the seat and disc. The velocity through a slightly opened valve is really something, especially when you are shooting to atmosphere, as you are here."

Mac laughed. "I don't blame the valve for leaking. It's a wonder that it holds up as long as it does."

"So that's what's doing the damage!" exclaimed Clint. "I've sort of been blaming the night operator for not closing the valve tight — not that he doesn't try hard. But with that long chain, it's difficult to know what you're doing." He squinted sideways at Mac. "I suppose you think I should put a gate in that line and then open and close two valves instead of one."

"Not at all," said Mac. "It's a first principle of engineering that there should be a gate valve at the header on every branch line so that the smaller lines can be serviced without shutting down the whole plant. If you had that valve at the header, you would not have to bank your boilers or close the two gate valves on the boiler leads. In that case, you would be operating one valve instead of two."

"And I'd get along without firing that standby boiler, too," said Clint. "But, Mac, the only way we could get a gate valve in there would be by putting it in upside down. You just can't do that."

"Why not?" asked Mac in surprise.

Put Gate Valve Upside Down

"Well, you just don't. You were talking about the condensate forming in that line. The bonnet of that valve would be full of water all the time. What do you think would happen to that packing?"

"Nothing," replied Mac.

"What?" Clint almost shouted. "You, a gasket salesman, and try to tell me that it doesn't hurt packing to keep it wet all the time?"

"Do you have a boiler feed line?" inquired Mac.

"Of course — ." Clint raised his eyebrows as the thought struck him. "Oh! I see what you're getting at. The packing in the boiler feed valves is always wet. Well, where does the notion that you can't put a valve in upside down come from?"

"Probably from the fact that people don't keep their stuffing boxes full and snugged up properly. It's an old stunt to keep pulling up the gland bolts until the packing is as solid as a rock without adding any packing rings. Finally the box will leak; and usually before they get around to doing something about it, the stem is cut and a major repair job is in order."

"Hmmmmm — , you'd have to shut down to pack the gate valve," declared Clint.

"You build in preventive maintenance when you design piping properly." He shook his head sadly. "Clint," he said wearily, "it's elementary that there are two ways to pack a gate valve under pressure. Back seating the valve is one way, but that requires a lot of care. It's easy to get burned that way, and it is positively dangerous to attempt it with anything like high pressure. The other way is to close the valve tight, but again you have to know what you're doing. Nine times out of 10 it works."

"I don't know," argued Clint. "Usually those things are done in a hurry, and the men get careless about safety precautions."

Mac grinned at his friend. "Boy, what an argument for the piping inspector. He can become an expert on the matter of servicing valves and do the job so that no one has to worry about it. When he has pulled up a gland about a third of the way, he will apply his expert knowledge and slip in an additional packing ring or two. By keeping his boxes full, he avoids any trouble, and you don't even know that he has done it."

Clint was reluctant to give up. "If you put the handwheel down on that gate, you'd have to provide some means to get up there to operate the valve."

"What's the matter with an extension stem?" asked Mac.

"Well, I suppose you could do that. Of course, it means closing the gate after every blow of the ash conveyor. There would still be some steam in the line. You certainly wouldn't advocate using the gate as a throttle valve?"

"No," declared Mac. "I said that, properly designed, there would be a gate at that header and that it would save you a lot of trouble in servicing this globe valve. You still need to do a bit of preventive maintenance on that globe."

"What's that?" snapped Clint.

"I suppose that you've got the pressure on top of the disc?" Mac pointed to the valve.

"Yep!" replied Clint shortly.

Install Condensate Drain

"All right. Tap into the body of the valve just ahead of the bridge wall. There should be a boss on the valve for that purpose. At any rate, a little 3/8 in. line will do nicely. Run it down here beside the boiler to a convenient drain, and put a nice new plug type globe valve with pressure on top of the disc into that line. Then when you are about to blow your ashes, just open the little valve until all the condensate has drained out, and go ahead." Mac chuckled. "Nice and easy, and no Sunday work involved."

"By gosh, that is a solution." He made a face at Mac. "That is, if your theory about what is causing the trouble is correct."

"Don't worry about the theory," laughed Mac. "But I'd be inclined to do something else to that valve."

"Now what?" demanded Clint.

Use Hammer Blow Chainwheel

"Why not put a hammer blow chainwheel on that valve? It would save Harry from trying to hang himself every now and then. Used with a fair amount of care, you would be sure that the globe valve was always closed."

"That seems to be a peach of an idea," agreed Clint. "Wonder if that would hurt the valve?"

"There is little chance of damage with a hammer blow chainwheel. It's different when a husky lays onto one of those things with all his strength. Then you really can damage even a globe valve. But a chainwheel has a lot of lost motion. Like with anything else, Clint, use sense with equipment to do the work it was intended to do, and you will generally keep out of trouble."

Pick, Train Maintenance Man

They had walked to the front of the boiler. Mac's eyes roved critically over the piping, coming to rest on a wet spot on the floor. As Mac gazed steadily at the spot, the pose attracted Clint's attention. He got one look at the wet spot and his eyes shot up to where the drip originated at the stem of a valve in the boiler feed line. "Oh!" he said softly. "I see what you mean."

Mac's silence was eloquent. They walked toward the stairs, reaching the office before either spoke. Finally Clint said, "All right Mac, you win. Tell me how to do it."

Mac sat down. "I've told you how one friend of mine worked out the problem. Pick your man. Spend some time each day for quite a while in training him to think about just one thing: preventive maintenance. Work out his routes with him so that he can cover all of the piping in a relatively short time without taking too many steps. Show him how to pull up a stuffing box under pressure and how to replace or add rings to the packing. Teach him to replace a gasket and to check a valve, to make sure that it is in good operating condition. Above all, provide him with good packing and the proper gaskets."

Mac made a grimace at his friend. "That's quite an order, but it can be done. The fellow should become a real expert after a while," Clint observed thoughtfully.

Study Problems with Inspector

"Once he gets on to his job, give him an understudy, someone whom he can train in turn, so that if anything happens to the old fellow, you won't land right where you are now." Mac laughed. "It won't be any fun to go back to Sunday work once you get used to going out with your family. You will need to study every problem like that globe valve with your piping inspector and work out solutions such as that drain. This man is not supposed to take over your thinking, too, you know."

"Well, it looks as though we are going to have a piping inspector shortly," declared Clint, grinning. "Thanks a lot for all your ideas."

"One thing more, Clint." Mac got up to go. "Don't give this man anything else to do. His job is preventive maintenance — that and that alone. Curb any temptation to make a handyman out of him."

They shook hands cordially. "Good luck and many bright Sundays," laughed Mac as he left.

Air Condition, Water Cool Livestock

. . . to increase farm profits

WITH MORE new air conditioned livestock buildings under construction at agricultural experiment stations across the country, alert farmers are already proving them profitable in use, according to a recent article in Farm Journal.

A Georgia hog grower uses 1 ton air conditioners at each end of his farrowing house. Although he spends $35 per month for electricity, plus depreciation, he saves more pigs per litter. He got the idea when he observed that hogs farrowing during cool weather raised nine pigs, whereas sows that farrowed in hot weather raised only four pigs each.

Steers in California given water showers in 100 F weather gain 1/3 lb per day faster than steers under shade without water. While it is 10 F cooler under the showered shade, it is 9 F cooler still under water soaked suspended burlap.

One farmer, who feeds 6500 cattle a year, has water piped from a nearby creek to the barn roof. When it's 80 F or above, a 3 hp pump circulates water through lateral lines across the roof, flooding it. Water runs down eavespouts and back into the creek. This water cooling helps cattle gain 1/4 to 1/2 lb more per day.

HPAC DATA SHEET

Solar Irradiation of South-Facing Inclined Surfaces

By F. W. Hutchinson* and M. O. Cotter**

THIS IS THE FIRST of a series of three data sheets covering the hourly and monthly irradiation of inclined surfaces facing south, east or west, or southeast or southwest, respectively.

Each data sheet presents tables covering latitudes 30, 35, 40, and 45 deg. Solar data at each sunlit hour of the day is given for each of the 12 months. Hence, interpolation between the three data sheets will permit direct determination of the instantaneous rate of solar irradiation of any inclined wall facing east through south through west, for any hour of any month, at any latitude between 30 and 45 deg.

Months are arranged in pairs around December and June, as the two months for which unique solar conditions apply. Thus, because of symmetry based on solar geometry, the solar altitude, H, and azimuth, A, can for engineering purposes be taken as the same for January and November, and likewise for each of the other four pairs of months. On this basis, the calculated value of the cosine of the angle of incidence, cos i, (defined as the angle between the actual direction of the sun's rays and a normal to the surface) can be considered exact. The value of the actual angle, i, as given in the table, is taken as that angle which comes closest to having a cosine numerically equal to the calculated value. In the case of horizontal surfaces, the procedure is reversed, since for this case the value of the angle of incidence is known as the difference between 90 deg and the solar altitude. The value of cosine i for horizontal surfaces is therefore the true cosine of known angle i.

For convenient computation, two approximations have been made. Thus I_o, the direct rate of irradiation on a plane normal to the sun's rays, is actually a maximum in January and decreases symmetrically for months on either side of January. Also, the value of I_o is materially affected by the amount of moisture in the atmosphere, hence has a different base value in summer than in winter. The I_o values used in the data sheets for the cooling season were based on the recommended curve of Parry Moon [Journal of the Franklin Institute, November 1940]. But the I_o values used in the data sheets for the heating season were taken from a modification of the Moon curve [July 1946 HPAC, ASHVE Journal Section.]

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In preparing this series of data sheets, the I_o selections of the earlier data sheets were continued. This means that slight discontinuities will be observed between summer and winter months, but each group of months should have irradiation rates which closely approximate the true values for the particular season. Thus, the information required from solar geometry for October, November, December, January, and February was taken directly from the earlier data sheets, but the I_o values given in the tables were taken for December, January, and February. Since the solar altitude at each hour on the 21st of January is equal to that at the same hour on the 21st of November, the indicated I_o taken for January will be exact when applied to November, except by that amount caused by seasonal change in the I_o base. This change amounts to approximately 5 parts in 435, hence is of the order of 1 percent and can be ignored.

The solar geometry and I_o values for June were taken from the cooling season data sheets. The values for the other three pairs of months (March-September, April-August, May-July) were taken from the cooling data sheets for the months of May, August, and September. For March, April, and July the calculated cosines and the I_o values must be regarded as approximations because:

1) The cooling data sheets were based on the first day of each month rather than the 21st, hence the solar altitude and the azimuth on the first of March, April, or July are not the same as on the first of May, August, or September, respectively. This deviation could have been avoided by re-calculating the cooling season months on the basis of the 21st day. But the error is slight, and it seemed preferable to maintain consistency between the present three data sheets and the three for the cooling season that have been published.

2) Since the indicated solar altitudes for March, April, and July are subject to slight error, the I_o values, based on these will also be slightly inexact.

3) As with the winter months, the base value of I_o will differ slightly — approximately 1 percent — between the two months of each pair.

Similar data for vertical walls facing south, east, west, southeast, or southwest was published for the heating season in the July 1949, *December* 1950, *and May* 1951 *HPAC, and for the cooling season in the September, October, and November* 1954 *HPAC.*

South Wall — **Table 1b** — Latitude 30°

Solar Time	I_o	30° Slope backward			60° Slope backward			Horizontal		
		i	cos i	$I_o$cos i	i	cos i	$I_o$cos i	i	cos i	$I_o$cos i
December										
8 a.m., 4 p.m.	192.7	54	0.584	112.7	64	0.446	86.0	79	0.1908	36.8
9 a.m., 3 p.m.	264.9	40	0.762	202.0	50	0.648	171.8	69	0.3584	95.2
10 a.m., 2 p.m.	285.7	28	0.881	251.7	38	0.787	224.8	61	0.4848	138.4
11 a.m., 1 p.m.	296.5	15	0.966	286.1	27	0.889	263.5	55	0.5736	170.0
12 noon	299.5	7	0.992	297.1	23	0.920	275.5	53	0.6018	180.2
Jan. or Nov.										
8 a.m., 4 p.m.	220.0	55	0.572	125.9	63	0.460	101.2	77	0.2250	49.5
9 a.m., 3 p.m.	276.0	42	0.743	205.0	48	0.664	185.2	66	0.4067	112.2
10 a.m., 2 p.m.	295.0	28	0.881	259.9	35	0.815	240.4	58	0.5299	156.3
11 a.m., 1 p.m.	305.0	16	0.959	292.5	24	0.910	277.5	52	0.6157	187.8
12 noon	308.0	10	0.986	303.6	20	0.940	289.5	50	0.6428	198.0
Feb. or Oct.										
8 a.m., 4 p.m.	253.0	57	0.550	138.9	61	0.488	123.5	72	0.3090	78.2
9 a.m., 3 p.m.	285.7	46	0.693	198.0	48	0.675	193.0	61	0.4848	139.5
10 a.m., 2 p.m.	302.5	33	0.836	253.0	32	0.847	256.1	51	0.6293	190.2
11 a.m., 1 p.m.	312.4	23	0.918	286.8	19	0.945	295.2	44	0.7193	224.8
12 noon	314.3	19	0.946	297.5	11	0.982	308.9	41	0.7547	237.4
Mar. or Sept.										
7 a.m., 5 p.m.	157.0	77	0.224	35.1	71	0.333	52.3	76	0.2419	37.8
8 a.m., 4 p.m.	223.0	65	0.420	93.7	60	0.496	110.6	64	0.4384	97.8
9 a.m., 3 p.m.	258.9	52	0.610	158.2	45	0.711	184.3	51	0.6293	163.0
10 a.m., 2 p.m.	274.6	42	0.742	203.8	30	0.864	237.1	41	0.7547	207.2
11 a.m., 1 p.m.	285.3	34	0.825	235.8	15	0.965	275.5	32	0.8480	240.2
12 noon	285.5	31	0.857	244.6	8	0.990	282.5	29	0.8746	249.8
Apr. or Aug.										
8 a.m., 4 p.m.	241.0	72	0.317	76.4	60	0.504	121.5	58	0.5299	127.7
9 a.m., 3 p.m.	270.4	60	0.495	133.8	46	0.701	189.5	44	0.7193	194.5
10 a.m., 2 p.m.	282.5	51	0.628	177.3	32	0.846	238.8	33	0.8387	236.9
11 a.m., 1 p.m.	289.4	45	0.709	205.2	19	0.944	273.2	22	0.9272	268.2
12 noon	290.7	42	0.743	216.0	13	0.976	283.5	18	0.9511	276.4
May or July										
8 a.m., 4 p.m.	251.0	73	0.290	72.8	62	0.465	118.0	54	0.5878	149.0
9 a.m., 3 p.m.	273.4	66	0.402	110.0	49	0.661	180.8	42	0.7431	203.3
10 a.m., 2 p.m.	285.5	58	0.529	151.0	36	0.812	231.8	29	0.8746	249.7
11 a.m., 1 p.m.	291.3	51	0.625	182.0	25	0.909	265.0	17	0.9563	278.6
12 noon	293.1	50	0.647	189.5	20	0.939	275.5	10	0.9848	289.0
June										
8 a.m., 4 p.m.	254.0	75	0.255	61.8	64	0.440	111.7	53	0.6018	152.7
9 a.m., 3 p.m.	276.2	66	0.400	110.5	46	0.694	178.0	39	0.7771	214.6
10 a.m., 2 p.m.	286.7	60	0.505	144.5	38	0.784	224.7	27	0.8910	255.1
11 a.m., 1 p.m.	292.3	55	0.571	166.7	27	0.889	259.7	14	0.9703	283.4
12 noon 1 p.m.	293.7	54	0.587	172.3	24	0.913	268.1	6	0.9945	292.0

South Wall — **Table 2b** — Latitude 35°

Solar Time	I_o	30° Slope backward			60° Slope backward			Horizontal		
		i	cos i	$I_o$cos i	i	cos i	$I_o$cos i	i	cos i	$I_o$cos i
December										
8 a.m., 4 p.m.	185.8	54	0.589	109.5	64	0.440	81.7	80	0.1736	32.3
9 a.m., 3 p.m.	245.1	41	0.753	184.5	53	0.603	147.9	73	0.2924	71.7
10 a.m., 2 p.m.	272.8	28	0.881	240.2	42	0.743	202.5	66	0.4067	111.0
11 a.m., 1 p.m.	285.7	14	0.970	277.2	33	0.840	240.0	61	0.4848	138.5
12 noon	291.6	0	1.000	291.6	29	0.875	255.1	59	0.5150	150.2
Jan. or Nov.										
8 a.m., 4 p.m.	195.0	55	0.570	111.3	64	0.439	85.7	79	0.1908	37.2
9 a.m., 3 p.m.	268.0	41	0.753	202.0	51	0.634	170.0	69	0.3584	96.1
10 a.m., 2 p.m.	288.0	28	0.885	255.0	39	0.780	224.6	62	0.4695	135.3
11 a.m., 1 p.m.	295.0	15	0.968	285.7	30	0.865	255.2	58	0.5299	156.2
12 noon	300.0	5	0.996	298.9	25	0.906	272.0	55	0.5736	172.0
Feb. or Oct.										
8 a.m., 4 p.m.	245.1	58	0.534	131.0	61	0.478	117.2	73	0.2924	71.7
9 a.m., 3 p.m.	281.7	45	0.701	197.5	48	0.666	187.4	63	0.4540	127.8
10 a.m., 2 p.m.	298.5	31	0.854	254.9	34	0.833	248.5	54	0.5878	175.4
11 a.m., 1 p.m.	306.4	17	0.955	292.5	22	0.924	283.0	49	0.6561	201.0
12 noon	310.4	14	0.970	301.0	16	0.961	298.1	46	0.6947	215.7
Mar. or Sept.										
7 a.m., 5 p.m.	157.0	76	0.243	38.2	74	0.282	44.2	76	0.2419	37.6
8 a.m., 4 p.m.	223.0	64	0.446	99.6	59	0.510	113.9	64	0.4384	96.8
9 a.m., 3 p.m.	258.9	50	0.640	165.7	43	0.733	189.9	51	0.6293	162.0
10 a.m., 2 p.m.	273.4	39	0.774	211.6	29	0.876	239.4	42	0.7431	203.2
11 a.m., 1 p.m.	280.8	31	0.855	240.0	15	0.967	271.5	35	0.8192	230.0
12 noon	283.3	28	0.882	247.0	4	0.998	282.0	32	0.8480	240.3
Apr. or Aug.										
8 a.m., 4 p.m.	241.0	69	0.354	82.8	59	0.509	119.2	58	0.5299	124.0
9 a.m., 3 p.m.	267.7	57	0.540	144.5	45	0.701	187.5	46	0.6947	186.0
10 a.m., 2 p.m.	281.6	47	0.678	190.8	30	0.870	245.0	34	0.8290	233.2
11 a.m., 1 p.m.	287.2	41	0.760	218.3	17	0.957	275.0	26	0.8988	258.0
12 noon	289.3	38	0.787	227.7	8	0.990	286.3	22	0.9272	268.2
May or July										
8 a.m., 4 p.m.	250.0	72	0.300	75.0	60	0.500	125.0	54	0.5878	147.0
9 a.m., 3 p.m.	274.6	62	0.466	128.0	45	0.704	193.0	41	0.7547	207.1
10 a.m., 2 p.m.	284.8	53	0.596	169.6	33	0.843	240.0	30	0.8660	246.5
11 a.m., 1 p.m.	290.2	47	0.681	197.5	21	0.936	271.5	20	0.9397	272.3
12 noon	291.9	45	0.707	206.4	15	0.965	281.8	15	0.9659	282.0
June										
8 a.m., 4 p.m.	253.0	73	0.265	67.1	60	0.495	125.3	52	0.6157	155.8
9 a.m., 3 p.m.	276.9	64	0.435	120.4	46	0.698	193.2	39	0.7771	215.0
10 a.m., 2 p.m.	286.7	55	0.573	164.2	31	0.857	245.5	27	0.8910	255.2
11 a.m., 1 p.m.	291.3	50	0.638	185.7	24	0.916	266.8	17	0.9563	278.5
12 noon	292.7	48	0.668	195.5	18	0.949	277.7	12	0.9781	286.2

HPAC DATA SHEET

South Wall **Table 3b** **Latitude 40°**

Solar Time	I_o	30° Slope backward			60° Slope backward			Horizontal		
		i	cos i	$I_o$cos i	i	cos i	$I_o$cos i	i	cos i	$I_o$cos i
December										
8 a.m., 4 p.m.	177.9	55	0.580	103.3	65	0.425	75.6	81	0.1564	27.8
9 a.m., 3 p.m.	221.4	42	0.745	165.0	55	0.570	126.2	76	0.2419	53.4
10 a.m., 2 p.m.	260.0	28	0.883	229.5	45	0.706	183.5	70	0.3420	88.9
11 a.m., 1 p.m.	272.8	15	0.967	263.9	38	0.793	216.4	66	0.4067	112.4
12 noon	276.8	5	0.996	275.5	35	0.819	226.5	65	0.4226	117.0
Jan. or Nov.										
8 a.m., 4 p.m.	180.0	56	0.556	100.0	66	0.412	74.1	81	0.1564	28.2
9 a.m., 3 p.m.	240.0	43	0.736	174.2	55	0.577	138.3	74	0.2756	65.5
10 a.m., 2 p.m.	276.0	28	0.882	243.5	42	0.743	205.1	66	0.4067	113.6
11 a.m., 1 p.m.	288.0	15	0.965	278.0	34	0.828	238.4	62	0.4695	135.2
12 noon	289.0	5	0.996	287.6	31	0.856	247.3	61	0.4848	140.0
Feb. or Oct.										
8 a.m., 4 p.m.	230.3	59	0.518	119.2	65	0.452	104.0	75	0.2588	58.9
9 a.m., 3 p.m.	272.8	44	0.722	197.0	49	0.652	178.2	66	0.4067	111.0
10 a.m., 2 p.m.	291.6	30	0.860	251.0	36	0.806	235.0	58	0.5299	154.5
11 a.m., 1 p.m.	299.5	17	0.958	287.0	25	0.907	271.9	53	0.6018	180.2
12 noon	302.5	6	0.995	301.0	22	0.928	280.9	51	0.6293	190.2
Mar. or Sept.										
7 a.m., 5 p.m.	133.5	76	0.239	31.8	75	0.256	34.2	78	0.2079	27.8
8 a.m., 4 p.m.	215.6	62	0.475	102.3	59	0.509	109.7	66	0.4067	87.6
9 a.m., 3 p.m.	247.0	49	0.660	163.1	45	0.705	174.1	56	0.5592	138.2
10 a.m., 2 p.m.	264.5	36	0.805	213.0	32	0.850	216.5	48	0.6691	170.4
11 a.m., 1 p.m.	274.6	26	0.901	247.4	17	0.954	262.0	41	0.7547	207.3
12 noon	276.9	21	0.934	258.5	13	0.975	270.0	39	0.7771	215.1
Apr. or Aug.										
8 a.m., 4 p.m.	237.9	67	0.386	91.7	59	0.521	123.9	59	0.5150	122.5
9 a.m., 3 p.m.	264.4	55	0.575	152.0	44	0.719	190.0	48	0.6691	176.9
10 a.m., 2 p.m.	278.9	45	0.712	198.5	29	0.872	243.0	38	0.7880	219.8
11 a.m., 1 p.m.	284.1	35	0.819	232.6	15	0.968	275.0	31	0.8572	243.5
12 noon	286.7	31	0.859	246.1	10	0.985	282.1	27	0.8910	255.3
May or July										
8 a.m., 4 p.m.	249.8	71	0.324	80.4	59	0.519	129.5	55	0.5736	143.0
9 a.m., 3 p.m.	272.1	59	0.518	141.0	42	0.745	202.8	43	0.7314	199.2
10 a.m., 2 p.m.	282.5	50	0.648	183.2	31	0.858	242.5	33	0.8387	237.1
11 a.m., 1 p.m.	288.3	42	0.740	213.2	18	0.952	274.1	24	0.9135	263.3
12 noon	290.2	40	0.768	222.7	11	0.982	284.9	20	0.9397	272.7
June										
8 a.m., 4 p.m.	255.0	73	0.285	72.7	59	0.515	131.4	52	0.6157	157.0
9 a.m., 3 p.m.	275.8	62	0.473	130.5	45	0.708	195.2	40	0.7660	211.1
10 a.m., 2 p.m.	285.5	52	0.615	175.7	31	0.861	246.0	29	0.8746	252.8
11 a.m., 1 p.m.	289.8	45	0.70.	203.3	19	0.945	273.9	21	0.9336	271.5
12 noon	291.5	44	0.718	209.3	14	0.970	282.9	16	0.9613	280.3

South Wall **Table 4b** **Latitude 45°**

Solar Time	I_o	30° Slope backward			60° Slope backward			Horizontal		
		i	cos i	$I_o$cos i	i	cos i	$I_o$cos i	i	cos i	$I_o$cos i
December										
8 a.m., 4 p.m.	177.9	57	0.546	94.4	70	0.347	60.0	87	0.0523	9.0
9 a.m., 3 p.m.	192.7	41	0.753	145.0	58	0.536	103.2	79	0.1908	36.8
10 a.m., 2 p.m.	217.5	31	0.858	186.5	51	0.630	137.0	77	0.2250	49.0
11 a.m., 1 p.m.	253.0	18	0.949	240.0	43	0.728	184.3	72	0.3090	78.2
12 noon	266.9	8	0.989	264.0	38	0.790	211.0	68	0.3746	100.0
Jan. or Nov.										
8 a.m., 4 p.m.	164.0	56	0.564	90.9	66	0.405	66.4	82	0.1392	22.9
9 a.m., 3 p.m.	220.0	43	0.729	160.5	57	0.551	121.3	77	0.2250	49.5
10 a.m., 2 p.m.	248.0	30	0.863	214.0	48	0.669	166.0	73	0.2924	72.0
11 a.m., 1 p.m.	270.0	17	0.957	258.5	40	0.770	208.0	68	0.3746	101.3
12 noon	276.0	6	0.995	274.3	36	0.807	222.7	66	0.4067	112.2
Feb. or Oct.										
8 a.m., 4 p.m.	217.5	59	0.521	113.3	64	0.431	93.1	77	0.2250	48.7
9 a.m., 3 p.m.	266.9	43	0.726	193.7	52	0.618	165.0	68	0.3746	100.0
10 a.m., 2 p.m.	281.7	30	0.865	243.5	40	0.762	214.3	63	0.4540	127.7
11 a.m., 1 p.m.	291.6	15	0.968	282.4	30	0.865	252.2	58	0.5299	154.5
12 noon	294.6	10	0.985	291.0	24	0.913	269.0	56	0.5592	164.9
Mar. or Sept.										
7 a.m., 5 p.m.	117.0	79	0.192	22.5	81	0.162	131.0	79	0.1908	15.7
8 a.m., 4 p.m.	207.2	62	0.462	95.3	60	0.498	103.2	68	0.3746	77.3
9 a.m., 3 p.m.	237.9	47	0.683	162.5	46	0.693	165.0	59	0.5150	122.6
10 a.m., 2 p.m.	258.9	34	0.832	215.5	33	0.843	218.3	51	0.6293	163.0
11 a.m., 1 p.m.	267.7	22	0.929	249.0	20	0.938	251.5	46	0.6947	186.2
12 noon	270.7	16	0.961	260.4	14	0.970	262.6	44	0.7193	195.0
Apr. or Aug.										
8 a.m., 4 p.m.	235.1	65	0.418	96.5	58	0.529	124.5	60	0.5000	117.5
9 a.m., 3 p.m.	260.4	52	0.613	159.7	43	0.726	189.0	50	0.6428	167.4
10 a.m., 2 p.m.	274.6	37	0.795	218.5	29	0.878	241.1	41	0.7547	207.5
11 a.m., 1 p.m.	280.8	31	0.857	240.5	15	0.968	271.6	35	0.8192	230.0
12 noon	283.3	26	0.900	255.0	8	0.990	281.0	32	0.8480	240.5
May or July										
8 a.m., 4 p.m.	249.8	65	0.417	104.2	48	0.664	166.0	55	0.5736	143.3
9 a.m., 3 p.m.	269.3	56	0.553	149.0	43	0.726	195.5	45	0.7071	190.5
10 a.m., 2 p.m.	280.8	46	0.695	195.0	29	0.875	245.5	35	0.8192	230.0
11 a.m., 1 p.m.	286.1	37	0.800	229.0	15	0.964	276.0	28	0.8829	252.5
12 noon	287.8	30	0.870	253.3	10	0.985	283.5	25	0.9063	261.0
June										
8 a.m., 4 p.m.	256.7	69	0.357	91.4	55	0.576	148.0	52	0.6157	158.1
9 a.m., 3 p.m.	273.4	52	0.609	166.5	32	0.845	231.0	42	0.7431	200.2
10 a.m., 2 p.m.	283.3	48	0.668	189.3	29	0.876	248.1	32	0.8480	240.3
11 a.m., 1 p.m.	287.8	41	0.750	216.0	16	0.961	276.8	25	0.9063	261.0
12 noon	289.8	39	0.778	225.5	9	0.988	286.4	21	0.9336	270.5

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Size Distribution and Concentration of Air-Borne Dust

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This paper is the result of research sponsored by the AMERICAN SOCIETY OF HEATING AND AIR-CONDITIONING ENGINEERS, INC., in cooperation with the Mechanical Engineering Department, University of Minnesota, Minneapolis, Minn.

SUMMARY — Measurements of particle size distribution of air-borne dust samples taken in the particle technology laboratory made by light microscope and centrifuge sedimentation are reported. Their validity was checked by comparison of the calculated optical densities with those measured by photometric evaluation of dust spots. This investigation indicates that sedimentation size analysis of air-borne dusts collected on millipore filters in combination with photometric evaluation of dust spots is a practical procedure for evaluating the size distribution of air-borne dusts, down to about 0.3 μ (microns).

Other experiments in combination with calculations from light scattering theory show that the dust spot method for evaluating air-borne dust concentration is most sensitive to particles between 0.3 and 1.5 μ with peak sensitivity at about 0.7 μ.

SINCE AIR CLEANING devices are used under widely varying conditions of dust loading and dust character, it has become increasingly desirable to have available dust sampling and evaluation methods that can be used to determine the dust problem under given conditions. Such methods must be both comprehensive and economically practical. The work reported here describes a combination of methods that appears to meet this need for a practical method of obtaining air-borne dust samples and evaluating their concentration, character and particle size distribution for engineering purposes.

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[1]Exponent numerals refer to References.

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Sampling Methods

The desirability of making a size distribution analysis on the collected samples of air-borne dust limits the sampling methods that can be used.

Thermal precipitation is impractical because of the extremely low sampling rates permissible.

Liquid impingers are not efficient collectors of particles below about 1 μ. Jet impactors[1] require careful design and use to collect small particles in a manner suitable for accurate size analysis of the particles below 1 μ.

Of the remaining methods, sampling by filter and by electric precipitor appeared to be the most adaptable to the needs of this study.

Electric precipitation permits reasonably high sampling rates and easy separation of the sample from the collection chamber.

Of the high efficiency filter media suitable for aerosol sampling[2], only

the millipore filter was found suitable for the collection of samples for size analysis. These filters are efficient enough so that they may be considered absolute on most air-borne dusts[2,3]. Microscope size analysis, up to the limit of resolution of the light microscope, can be made on the filter directly. The solubility of these filters in acetone and certain other organic solvents permits ready dispersion of the collected particles into a suspension suitable for sedimentation size analysis.

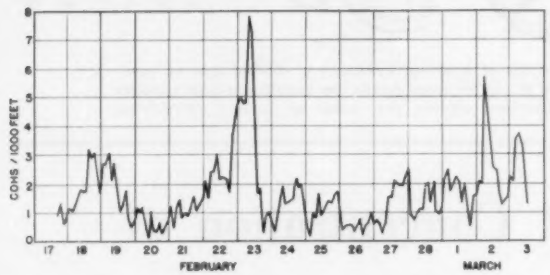

Fig. 1—Relative dust concentration measured in the University of Minnesota particle technology laboratory for the period covered by this study as measured by the standard *AISI* sampler

Fig. 2—Photometric spot evaluator

Measurement of Particle Size Distribution

Problems involved in the measurement of the size distribution of air-borne dusts are more difficult than might appear at first thought. Air-borne dust usually has a broad size distribution ranging from above 30 μ to below 0.3 μ. This broad distribution severely limits the usefulness of light microscopic methods because of the limit of resolution at about 0.3 μ and because of the small probability of seeing the large particles.

Sedimentation methods also suffer from certain limitations. Gravity sedimentation, whether in air or liquid, is time-consuming and unreliable below about 1 μ. Liquid sedimentation methods, using centrifuges to increase the speed and convenience of analysis[4], measure either the volume or weight distribution. The weight or volume readings are least accurate at the fine end of the distribution where the accuracy must be the highest if the weight distribution is to be transformed to a surface or number distribution. Another very real problem in using liquid sedimentation methods is the determination of the exact relationship between the measured distribution and the actual distribution of aggregates in the air.

In view of these serious limitations of any one method of size measurement, it is probable that any procedure for measuring the size distribution of air-borne dusts should incorporate independent measurements by more than one method, if confidence is to be placed in the results.

Apparatus and Methods

As a result of preliminary experimental work, microscope size measurement on millipore filters and centrifuge sedimentation on samples collected both wet and dry with the electrostatic sampler were selected for further study. During the course of the work, successful procedures were developed for collecting samples on the millipore filters for sedimentation. Sampling with the electrostatic sampler was, therefore, discontinued in favor of sampling with the millipore filters.

To provide a completely independent check on these two methods, the optical density of simultaneous samples collected on chemical filter paper, glass filter paper and millipore filters was compared with the equivalent optical density calculated by light scattering theory from the size distributions.

All samples taken were of the normal laboratory air existing at the time. As shown in Fig. 1, the dust

Table 1—Calculation of Effective Scattering Area for Atmospheric Dust Sized by Microscope

(1) d microns	(2) n^a	(3) d^2 (microns)^2	(4) nd^2	(5) K	(6) Knd^2
<0.447[b]	4100	0.090	369	1.30	480
0.447	804	0.199	160	2.96	474
0.634	664	0.402	267	4.30	1150
0.895	75	0.80	60	3.56	214
1.268	25	1.61	40	2.50	100
1.82	14	3.31	46	2.15	99
2.51	7.1	6.30	45	2.00	90
3.58	6.1	12.8	78	2.00	156
5.06		25.6		2.00	
7.15		51.0		2.00	
10.13		102		2.00	
14.3		204		2.00	
20.2	1	408	408	2.00	816
					3579[c]

[a] = for 82 fields; [b] = assumed size = 0.3 [c]Figure is $\Sigma K_1 n_1 d_1^2$, in (microns)^2. (Sample obtained 2/23/55).

spot discoloration measured by the standard *AISI* sampler[5] ranged from relatively clean to moderately dirty.

Size Analysis by Microscope

Hydrosol type millipore filters were used for sampling because of their

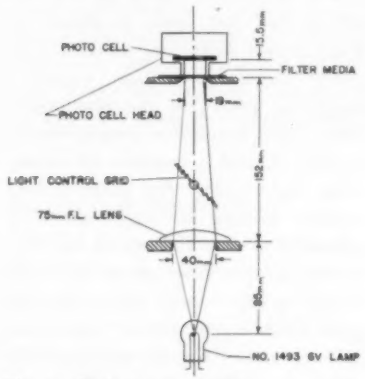

Fig. 3—Optical system of dust spot evaluator

Counting was done with a Porton reticule in a microscope equipped with a 10X ocular, a 97X 1.25 numerical aperture objective and a blue diffusing filter below the substage condenser. A multistage count method, suggested by Work[6], was used because of the wide size range of the dust. Approximately 1000 particles in at least 50 fields were counted. The results from a typical count are shown in columns 1 and 2 of Table 1, and also plotted in Fig. 4, along with the equivalent volume distribution calculated with and without the single 20 μ particle.

Size Analysis by Sedimentation

The electrostatic sampler used is shown in Fig. 5. The chamber is rolled in at each end so that if desired about 15 ml of a liquid can be placed inside for wet collection.

added so that all of the oil would dissolve. The suspension was then centrifuged in a small laboratory centrifuge for about 1 hr to precipitate all particles above about 0.15 μ. The supernatent liquid was then siphoned off and the particles resuspended in sufficient 30 percent naphtha, 70 percent acetone mixture to fill the feeding chamber of the centrifuge tube. Particle size distribution was then determined using the apparatus and procedures previously described[4] with acetone as the sedimentation liquid. Acetone is the only sedimentation liquid tried which yielded a size distribution which would check with the microscope and photometric data. This is fortunate because the low vis-

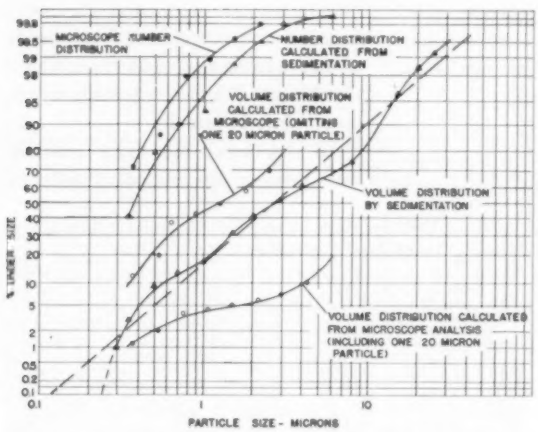
MICROSCOPE NUMBER DISTRIBUTION
NUMBER DISTRIBUTION CALCULATED FROM SEDIMENTATION
VOLUME DISTRIBUTION CALCULATED FROM MICROSCOPE (OMITTING ONE 20 MICRON PARTICLE)
VOLUME DISTRIBUTION BY SEDIMENTATION
VOLUME DISTRIBUTION CALCULATED FROM MICROSCOPE ANALYSIS (INCLUDING ONE 20 MICRON PARTICLE)
% UNDER SIZE
PARTICLE SIZE - MICRONS

Fig. 4—Comparison of Microscopic and sedimentation size analysis on dust sample collected February 23

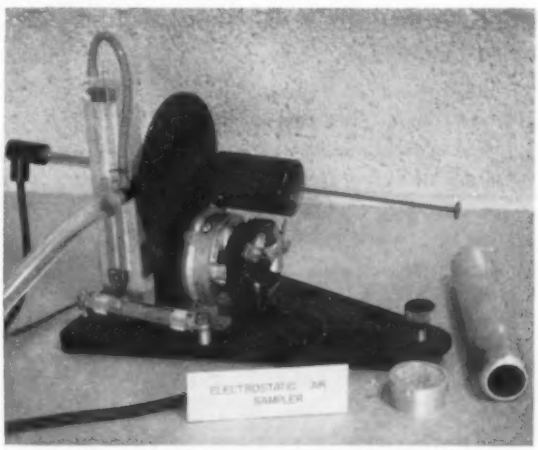

Fig. 5—Electrostatic air sampler head showing electrodes, sample tube, and lint screen

lack of grain when viewed under a high power oil immersion lens. Sampling time and rate were adjusted to give a final optical density of about 0.03. After first measuring the optical density of the filter with the photometer shown in Figs. 2 and 3, the microscope slide was prepared as follows: — a ½-in. sq. of the filter was placed face down on a cover slip and, after wetting with immersion oil, the cover slip was carefully placed on a slide, care being taken to prevent any relative motion between the filter and the cover slip.

Rotation of the tube at 10 rpm about its axis maintains a thin film of liquid on the inside of the tube. A 100 mesh stainless steel screen is placed over the tube entrance to keep out large particles which would interfere with the sedimentation analysis. A separate evaluation method for these large particles is under development.

USP light mineral oil was used when the sampler was operated wet. At the end of a run, the mineral oil was washed out with acetone to which just enough naphtha had been

cosity of acetone (0.3 centipoise) permits relatively rapid size determinations to below 0.2 μ.

When the electrostatic sampler was operated dry, the precipitated dust was washed from the tube with pure acetone. The rest of the procedure was identical to that just described.

Samples collected on the aerosol type millipore filters were released by dissolving the dirty filter in pure acetone in a centrifuge tube and then following the rest of the procedure.

All of the sedimentation size analysis work here reported was done

with 0.75 mm bore capillary tubes and the apparatus previously described[4]. In order to get sufficient sediment height, the sampler was run 4 to 6 hr at a flow rate of about 2 cfm when sampling the relatively clean air in the laboratory. It is believed that special tubes and slight modification of the optical system of the reading devices will eventually permit a sufficient sample to be obtained in 1 to 2 hr and eliminate the necessity of taking a separate sample for photometric evaluation. The amount of sample required at present gives too high an optical density for accurate photometric evaluation.

Some typical size distributions of air-borne dusts determined in this way are given in Fig. 6.

Photometric Measurements on Dust Spots

Though photometric measurements of dust spots on filter paper can not be made to yield a complete size distribution, such measurements are related to the total projected area of the particles in a given quantity of air. Therefore, these measurements offer an independent method of checking the size distribution and concentration measurements made by other methods. Derivation of the relationships between photometric data and the size distributions is given in the Appendix.

Two different methods and three different filter media were used for dust spot sampling. For a continuous 24-hr record, an *AISI* automatic air sampler[5] was used. This sampler automatically takes a sample every 2 hr on No. 4 filter paper tape. One of the limitations of this instrument is the necessity of comparing light transmission adjacent to the spot with that through the spot in order to calculate the relative concentration in cohs† per 1000 ft as defined by Equation A-1 (see Appendix). For the No. 4 filter paper and for some glass fiber that was also tried, the standard deviation in light transmission between adjacent areas 1.5 in. apart averaged about 2 percent. It may be seen from Table 2 that the probable percent error in the calculated dust concentration becomes rather large at low dust levels.

†A measuring unit, the amount of carbonaceous material corresponding to an optical density of 0.01; also optical density × 100.

When more accurate photometric data were desired, samples were taken on filter media held in a commercial holder for the 47 mm size millipore filters and the light transmission evaluated over the same area before and after sampling.

The photometer used to evaluate all of the dust spots is shown in Figs. 2 and 3. It consists of a high grade electronic voltage regulator supplying power to the photometer lamp, the photometer proper shown in Fig. 3, and a commercial microscope light meter. The latter is convenient because its high sensitivity permits full scale deflections for relatively opaque filter materials such as the millipore and glass fiber papers. Table 3 gives typical light transmission values for the various filter materials. With reasonable care, light transmission measurements accurate to about 0.3 percent can be made with this apparatus. Though this instrument is reasonably satisfactory, a more versatile photometer of the compensated, null type, which should give 0.1 percent accuracy, is now being designed.

To determine the exact relationship between the optical density as

Table 2—Probable Error in Dust Concentration Measured by the *AISI* Sampler, Caused by Variations in Light Transmission Through the Filter Tape

Cohs per 1000 ft	Optical Density	95% Confidence interval[a] on Cohs per 1000 ft
4	0.190	± 10%
2	0.950	± 20%
1	0.470	± 32%
0.5	0.024	± 73%

[a]For 2 percent standard deviation in light transmission.

Table 3—Percentage Light Transmission of Various Filter Media

Media	% Transmission
Opal glass standard	26.7
Glass fiber paper	4.0
Filter paper No. 41	16.3
Filter paper No. 4	15.0
Aerosol Type Millipore Filter	2.8
Hydrosol Type Millipore Filter	2.3

Table 4—Summary of Size Analysis Data on Atmospheric Dust Samples Taken in the Particle Technology Laboratory

Date	Time P.M.	Length of Run Hours	(1) Method of Collection	(2) Assumed gm/cc	(3) Color of Sediment	(4) Concentration mg/m³	(5) d'_g microns	(6) σ_g	(7) d_n microns
2/20	1:00	6	Note 1	2.1	Lt Brn	0.096	4.3	2.47	0.65
2/22	6:00	6	Note 1	2.1	Dk Brn	0.172	7.9	1.66	0.95
2/23	5:30	6	Note 1	2.1		0.061	2.3	3.36	0.49
2/25	9:45	5	Note 1	1.6		0.098	4.6	3.11	0.66
2/25	5:00	8	Note 2	1.6		0.102	3.3	2.56	0.54
2/27	6:30	6	Note 3	1.6	Black	0.081	2.4	3.16	0.62
2/28	4:30	4½	Note 3	1.6	Black	0.121	3.1	2.75	0.88
2/28	10:00	6	Note 3	1.6	Black	0.080	2.1	2.60	0.59
3/1	5:30	6	Note 3	1.6	Note 4	0.049	1.8	3.27	0.46
Microscope Data									
		6 min.	Note 3				0.77	1.91	0.32
		6 hrs	Note 3				0.78	1.85	0.30

Sedimentation Data					
Date	(8) d_n microns	(9) Note 5	(10) Cohs per 1000 ft	(11) *AISI* Sampler Media	(12) *AISI* Sampler Cohs per 1000 ft
2/20	2.60	10000	1.24	Paper 4	0.46
2/22	5.10	4400	0.48	Paper 4	3.27
2/23	1.54	16300	0.85	Paper 4	0.75
2/25	2.58	10800	1.16	Paper 4	1.14
2/25	2.01	13800	1.58	Paper 4	1.48
2/27	1.61	19100	1.72	paper 4	2.05
2/28	2.35	11200	1.48	Paper 4	1.44
2/28	1.68	17000	1.54	Paper 4	1.51
3/1	1.13	27000	1.50	Glass Fiber	1.10
Microscope Data					
2/8	0.56		1.83		
2/23	0.62		0.98	Paper 4	0.75

Note 1 — Wet electrostatic collection; *Note 2* — Dry electrostatic collection; *Note 3* — Millipore collection; *Note 4* — Indicates sediment ½ brown and ½ black; *Note 5* — $\Sigma(K_1 v_1)\ (1/d_1)$ in square centimeters per cubic centimeter.

measured on the filters and that predicted from light scattering theory, a number of additional experiments were carried out with varying photocell arrangements and with the filter immersed in liquid. These experiments were performed using the commercial photometer and a standard microscope and lamp. By using various numerical aperture objectives on the microscope, light could be accepted through varying cone angles.

Results and Discussion

Table 4 summarizes the data obtained from the various size distribution measurements and calculations. Column 2 gives the particle densities that were assumed in calculating the centrifuge tables and for determining the dust concentrations in column 4. As a result of average density determinations on dust taken from a number of electrostatic air cleaners, it was originally believed that the average density of atmospheric dust was about 2.1 g per cc. However, some approximate specific gravity separations indicated that density of the dust samples being collected in the laboratory was probably closer to 1.6. This value was, therefore, used for some of the later runs. Work is proceeding on a simple method for estimating the average density of the sediment collected in the centrifuge tube.

Columns 5 to 8 give a number of the parameters of the size distribu-

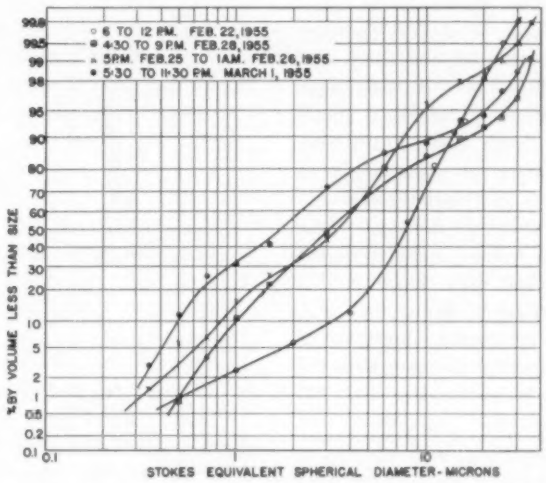
6 TO 12 PM. FEB. 22, 1955
4:30 TO 9 PM. FEB. 28, 1955
5PM. FEB. 25 TO 1AM. FEB. 26, 1955
5:30 TO 11:30 PM. MARCH 1, 1955
% BY VOLUME LESS THAN SIZE
STOKES EQUIVALENT SPHERICAL DIAMETER - MICRONS

Fig. 6—Typical sedimentation size distributions of atmospheric dust

Table 5—Light Transmission Studies on Different Filter Media With Two Different Photocells

(1) Filter Media	(2) Measured After Running-min.	(3) Photocell[a] Arrangement	(4) Optical Density Dirt Away	(5) Optical Density Dirt Toward	(6) OD Away / OD Toward
HA Millipore	15	A	0.040	0.024	1.67
HA Millipore	30	A	0.066	0.046	1.44
HA Millipore	60	A	0.119	0.093	1.28
HA Millipore	180	A	0.301	0.254	1.19
HA Millipore	180	B	0.308	0.193	1.60
Paper 41	15	A	0.024	0.024	1.00
Paper 41	30	A	0.046	0.047	0.98
Paper 41	90	A	0.104	0.104	1.00
Paper 41	90	B	0.103	0.099	1.04
Glass Fiber	15	A	0.193	0.169	1.14
Glass Fiber	30	A	0.327	0.298	1.10
Glass Fiber	15	A	0.195	0.172	1.13
Glass Fiber	30	A	0.351	0.321	1.09

[a]A = Photometer head as shown in Fig. 3. B = 60 mm diameter photocell lying in contact with the filter media.

Table 6—Calculation of Effective Scattering Area for Atmospheric Dust Analyzed by Sedimentation. Sample Collected 2/23/55

(1) d microns	(2) % Undersize by volume	(3) Midpoint of size range microns	(4) % in range	(5) $1/d$ cm^{-1}	(6) Area per size range (4) x (5)	(7) K (m = 1.5)	(8) Scattering area-cm^2 (6) x (7)	(9) % Scattering area less than size
0.25	0.1	0.225	0.1	44500	45	0.90	40	0.25
0.30	1.0	0.275	0.9	36300	327	1.04	340	2.3
0.35	3.0	0.325	2.0	30800	616	1.67	1030	8.7
0.40	5.0	0.375	2.0	26650	531	2.25	1190	15.9
0.50	9.2	0.45	4.2	22200	918	2.96	2720	32.6
0.70	13.0	0.60	3.8	16780	642	4.15	2670	49.0
1.0	16.9	0.85	3.9	11750	458	3.83	1760	59.8
1.5	31.0	1.25	14.1	8000	1130	2.50	2820	77.1
2	40.7	1.75	9.7	5720	554	2.18	1210	84.6
4	67.7	3.0	27.0	3330	900	2.00	1800	96.6
8	75.4	6.0	7.7	1660	128	2.00	256	97.1
14	93.8	11.0	18.4	910	167	2.00	335	99.3
20	98.5	17.0	4.7	588	59	2.00	118	99.9
25	99.2	22.5	0.7	444	4	2.00	8	99.96
30	100.0	27.5	0.8	358	3	2.00	6	100.0
							16303[a]	

[a]Figure is $\Sigma K_{(r)1}\ 1/d_1 = 16303$ cm^2 per cm^3

tions. Columns 9 and 10 were calculated using equations A-6 or A-8. Based on measurements on similar materials the porosity, θ, was assumed equal to 0.3 in calculating column 10.

Comparison of the cohs per 1000 ft calculated from the size distributions, column 10, and the values measured photometrically, column 12, shows agreement well within the factor of about two that would be predicted from a consideration of the assumptions entering into the light scattering calculations. All of the conclusions made in the following sections regarding the validity of the size distributions measured by sedimentation and the meaning of the dust spot method have been based on agreement within a factor of two.

While considerable information is available on light scattering coefficients for particles suspended in a transparent medium, none is available for particles in or on a filter as used in the conventional dust spot measurements. Therefore, certain simple experiments were carried

out to estimate the accuracy with which the light scattering theory for transparent media could be applied to particles on a diffusing filter medium.

One simple experiment is illustrated in Table 5. Optical densities were measured with the dirty surface toward and away from the light source. A study of column 6 shows that the millipore filters which have all the particles lying essentially in one plane at the surface may exhibit considerably different light transmission values under different conditions. The data shown in this table and other similar studies with the microscope using objectives of varying numerical aperture have led to the following conclusions:

1. The ratio of the optical density with the dirty surface away from the light to that with it toward the light decreases with increasing penetration of particles into the filter, decreases with increasing optical density and decreases with decreasing effective numerical aperture of the photocell.

2. The optical density of the filter with the dirty surface toward the light is probably the closest to and within a factor of about 1.4 of that which would be predicted from light scattering theory for transparent media.

The second conclusion is also supported by another simple experiment that was performed to see if the assumed index of refraction of 1.5 was reasonably close to the true value. In order to obtain the K values tabulated in column 7 of Table 6 from Fig. 7, it is necessary to assume a value of m. From microscopic observation η_p, and hence m in air, was estimated as 1.5. If this is near the correct value, measurements of the optical density of the particles on a millipore filter immersed in a liquid, having a refractive index near that of the particles, should be less by a calculable amount than for the same filter in air, providing also that the measured size distribution is correct. In Table 7 are some measurements made in air, and in four different liquids together with the calculated ratios for the microscope and sedimentation size distributions as given in Tables 1 and 6. The relatively good agreement indicates that the assumed refractive index of 1.5 is approximately correct, that the variation in K with p given in Fig. 7 is reasonably correct and that the measured size distributions are reasonably close to the effective size distribution of the particles on the dry filter and hence to the distribution of air-borne aggregates. This latter conclusion was further supported by microscopic observation of the particles resuspended after the sedimentation size distribution had been determined. The size and shape of the aggregates appeared to be the same as those on a dry millipore filter.

It will be noted in Fig. 7 that the highest K value occurs at a particle size of about 3 μ for m =1.1. This m value corresponds approximately to that of the dust suspended in acetone. This is confirmed by the fact that the suspension in the capillary of the sedimentation tube appears the most dense at about 1 to 3 μ during the analysis.

From these data, certain important conclusions can be drawn regarding the meaning and usefulness of each of the three methods of measurement used in this study.

Fig. 4 and Table 1 illustrate some of the limitations of the microscope method of measurement of the size distribution of air-borne dust. In Fig. 4 it will be noted that 72 percent by number of the particles counted lie at or below the limit of resolution, which means that the number distribution is probably considerably in error.

The accuracy of a weight or volume distribution calculated from the microscope number distribution is even more open to question because of the large volume of a few large particles relative to the volume of the small particles. However, due to the sharp decrease in K for both large and small particles, it is possible to calculate the equivalent optical density of dust spots with reasonable success from the microscope size distribution.

The limitations of the sedimentation method are not quite as numer-

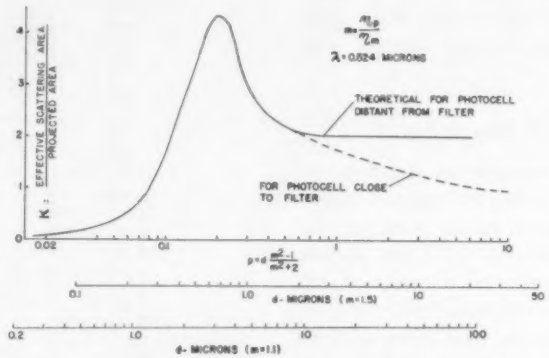
EFFECTIVE SCATTERING AREA / PROJECTED AREA
K =
THEORETICAL FOR PHOTOCELL DISTANT FROM FILTER
FOR PHOTOCELL CLOSE TO FILTER
λ = 0.524 MICRONS
d - MICRONS (m=1.5)
d - MICRONS (m=1.1)

Fig. 7—Universal light scattering curve (after Sinclair[5])

Table 7—Optical Density of Atmospheric Dust on a Millipore Filter Immersed in Different Fluids

Light Measuring Instrument	Fluid	η_m	OD Away	OD Toward
As shown in Fig. 3	Air	1.000	0.077	0.074
Microscope and Photometer Inst.	Immersion Oil	1.515	0.0313	
Microscope and Photometer Inst.	Benzene	1.501	0.0334	
Microscope and Photometer Inst.	Carbon Tet.	1.463	0.0310	
Microscope and Photometer Inst.	Water	1.330	0.0386	

Method of Determination	$\frac{\text{OD in air}}{\text{OD in liquid}}$
Measured (average for 4 liquids)	2.21
Calculated from Microscope (m = 1.1)	2.16
Calculated from Sedimentation (m = 1.1)	2.07

ous as for the microscopic methods, but must be kept in mine in interpreting size distribution measurements. Perhaps the largest uncertainty arises from the necessity of assuming a mean density in calculating Stokes' equivalent spherical diameter.

From Stokes' Law, it is possible to derive the following expression for the error in calculated particle size for given errors in particle density.

$$\%\text{ error in } d = 100\left[1-\sqrt{\frac{\rho_{true}-\rho_o}{\rho_{assumed}-\rho_o}}\right]$$

For example, if $\rho_{true} = 1.6$, $\rho_{assumed} = 2.1$, $\rho_o = 0.8$, the percent error in d would be 22 percent.

Since the projected area of the particles is proportional to the square of the particle diameter, the error in the cohs per 1000 ft calculated from the size distribution would be:

$$\text{Percent error in cohs per 1000 ft} = 100\,[1 - (\rho_{true} - \rho_o)/(\rho_{assumed} - \rho_o)]$$

For the values assumed, the percent error in the calculated cohs per 1000 ft would therefore be 38 percent. In practice, it is believed that the density of the dust can probably be estimated to within 15 percent. Under this condition, the error in particle size would be about 10 percent, and the error in calculated cohs per 1000 ft, about 20 percent.

A second limitation of the sedimentation method arises from errors in the cumulative size distribution curve of the fine particle size caused by compaction of the sediment column and the smallest increment in sediment height which is readable. For example, in Fig. 4 the volume distribution curve by sedimentation is dashed below 0.3 μ because the minimum readable increment corresponds to about 1 percent of the total sediment height.

In view of the known uncertainties in the various measurements and calculations, it may be concluded that the agreement between the calculated and observed cohs per 1000 ft in columns 10 and 12 Table 4 is within the experimental error. If this is the case, it is possible to draw a number of interesting conclusions regarding the meaning of the dust spot method when used to measure atmospheric dust concentration.

Fig. 8 is a plot of the effective scattering area contributed by each particle size range of the volume distribution curve, by sedimentation shown in Fig. 4, relative to the total scattered by the dust. From this curve and from columns 2 and 9 of Table 6, it is apparent that the optical density of the dust spot is due primarily to particles between about 0.3 and 1.5 μ size. From Table 6

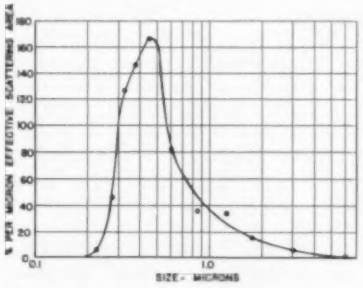

Fig. 8—Relative effective scattering area of the various size ranges of the sample collected February 23. Analysis by sedimentation

it may be noted that the 40 percent by volume of particles between 0.3 and 2 μ contributes 83 percent of the total optical density. It may also be noted from Fig. 7. that the rapid decrease in K for small particle sizes means that the dust spot method is not sensitive to particles below about 0.3 μ, if white light is used.

This may be a possible explanation for the relatively good agreement between the calculated and observed coh values. The microscopic method is insensitive to these small particles, because they are below the limit of resolution; the sedimentation method is inaccurate, because there is only a small percent by volume below this size, and the photometric method is insensitive to these small particles, because of the rapid decrease in K.

Thus, there is a need for a practical method of size distribution measurement below the 0.3 μ size range. There is some hope that the sedimentation method could be useful in this range if proper techniques were developed by comparison with the electron microscope.

From Fig. 7 it is seen that for an m value of 1.5, the peak in K occurs at about 0.7 μ. This means that the dust spot method is most sensitive to particles of this size. However, the peak in the effective scattering area of the dust sample shown in Fig. 8 occurs at about 0.5 μ because of the relatively large volume fraction of dust particles between about 0.3 and 1 μ.

Though the nine analyses shown in Table 6 certainly do not represent the range of size distribution and concentration of atmospheric dust that may exist, these data do show that considerable variation in size distribution may occur. Visual observation of the color of the sediment in the sedimentation has also revealed that the character of the dust is variable. For example, the sample taken on February 20 was collected during a very high south wind. The sediment for this analysis was a very light brown in contrast with the black color exhibited on days when the wind velocity was low and was blowing from the industrial area of Minneapolis, Minn.

Since the procedure here described is intended for the analysis of the finer particle sizes, a separate method for the evaluation of lint and other large particles is under development. When the lint evaluation procedure has also been developed, it is planned to use the combined techniques to make a study of the size distribution and concentration of airborne dust under a variety of atmospheric, industrial and residential conditions.

Acknowledgments

The authors wish to acknowledge the assistance of W. E. Engebretson, graduate student in mechanical engineering, in carrying out much of

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APPENDIX

Derivation of relationship between number and volume particle size distribution and the optical density of a dust spot: In order to compare particle size distribution and concentration measurements with discoloration, it is necessary to calculate the equivalent discoloration from the size distributions. A convenient unit for comparison is the coh per 1000 ft of air suggested by Hemeon[6].

$$\text{cohs per 1000 ft} = \frac{10^5 \times \log_{10} \frac{I_o}{I}}{\frac{qt}{A}} = \frac{10^5 \times \log_{10} \frac{I_o}{I}}{l} \quad \text{(A-1)}$$

Thus, the cohs per 1000 ft are actually the hundredths of a unit of optical density accumulated on the filter per 1000 linear ft of air drawn through the filter.

For spherical particles, the optical density for particles of diameter d is given by the following[7]:

$$\log_{10} I_o/I = 0.433\ K\ N_v\ d^2\ l \quad \text{(A-2)}$$

Substituting Equation A-2 into A-1 yields

$$\text{cohs per 1000 ft} = 4.33 \times 10^4\ K\ N_v\ d^2 \quad \text{(A-3)}$$

The total scattering coefficient, K, is a complex function of the ratio of the particle diameter to the wave length of the light used, the absorption, the refractive index, the shape of the particle, the geometry of the optical system used, as well as other factors. However, Sinclair[8] has shown that for a given wave length, to a good approximation, K can be expressed as a function of d $[m^2 - 1/m^2 + 2]$ where m is the relative refractive index of particle to suspending medium. This function is plotted in Fig. 7. Since K depends on particle size, it must be included in the formulas for calculating the total effective scattering from the size distributions.

Volume Distribution: Since the effective scattering area per particle is Kd^2 and the volume per particle is $\pi/6\ d^3$, the effective scattering area per unit volume of particles of size d is $(6\ K/\pi)\ (1/d)$, or for a size distribution is

$$(6/\pi)\ \Sigma\ K_i\ v_i\ 1/d_i$$

therefore

$$N_v\ Kd^2 = (V_p/Q)\ (6/\pi)\ \Sigma\ K_i\ v_i\ (1/d_i) \quad \text{(A-4)}$$

and Equation A-3 becomes

$$\text{cohs per 1000 ft} = 4.33 \times 10^4\ (V_p/Q)\ (6/\pi)\ \Sigma\ K_i\ v_i\ (1/d_i) \quad \text{(A-5)}$$

Or since $V_p = V_o\ (1 - \theta)$, Equation A-5 finally becomes

$$\text{cohs per 1000 ft} = 8.28 \times 10^4\ [V_o(1 - \theta)/Q]\ \Sigma\ K_i\ v_i\ (1/d_i) \quad \text{(A-6)}$$

Equation A-6 has been derived for spherical particles. Although no K values are available at the present time for other particle shapes, Ellison[9] indicates that most irregular particles can probably be treated as spheres of equivalent volume.

Table 6 illustrates how the $\Sigma\ K_i\ v_i\ (1/d_i)$ is calculated from the volume-size distribution determined by sedimentation.

Number Distribution: For a number size distribution determined by microscope count the average effective scattering area per particle is given by $(\Sigma\ K_i\ n_i\ d_i^2)/N$ and,

therefore,

$$\text{cohs per 1000 ft} = 4.33 \times 10^4\ N_v(\Sigma\ K_i\ n_i\ d_i^2)/N \quad \text{(A-7)}$$

Since $N_v = (N/Q)(A/A_c)$ Equation A-7 becomes

$$\text{cohs per 1000 ft} = 4.33 \times 10^4\ (A/A_c\ Q)\ \Sigma\ K_i\ n_i\ d_i^3 \quad \text{(A-8)}$$

Table 1 illustrates the method for calculating $\Sigma\ K_i\ n_i\ d_i^3$ from the microscope number distribution.

Nomenclature

A = area of filter.
A_c = area of filter counted by microscope.
d = particle diameter — microns, centimeters or feet, as noted.
d_g = geometric mean of number size distribution.
d'_g = geometric mean of volume or weight size distribution.
d_n = arithmetic mean of number size distribution.
d_v = arithmetic mean of volume size distribution.
d_a = size of particle of average projected area.
I = intensity of light transmitted through a dirty filter.
I_o = intensity of light transmitted through a clean filter.
K = total scattering coefficient.
K_i = scattering coefficient for particles of size i.
l = linear feet of air sampled = Q/A
m = η_p/η_m
N = total number of particles counted during a microscope count.
N_v = number of particles per unit volume of air.
n_i = number of particles in class interval i.
OD = optical density = $\log_{10} I_o/I$
q = sampling rate, volume per unit time.
Q = total volume of air sampled.
t = elapsed time.
V_p = total volume of particles collected = $(1 - \theta) \times$ sediment volume in centrifuge tube.
V_o = apparent sediment volume in centrifuge tube.
v_i = volume fraction of particles in class interval i.
ρ = particle density, grams per cubic centimeter.
η_p = refractive index of particle.
η_m = refractive index of surrounding medium.
θ = sediment porosity = 0.26 for spheres.
σ_g = geometric standard deviation of a particle size distribution = $\sqrt{\frac{d \text{ at } 84\%}{d \text{ at } 16\%}}$

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Index for Evaluating Heat Stress in Terms of Resulting Physiological Strains

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SUMMARY — A rational approach is described and is proposed for evaluation of heat stress in terms of: (1) thermal load which is imposed on a *standard man*; (2) capacity of the environment to accept the load; and (3) physiological capacity to meet the demands over a period of 8 hr. The *standard man* represents a composite of young, fit, acclimatized men who have been subjects of physiological investigation of the effects of heat in the laboratory and in the field.

HEAT is a stress faced by all human beings. It is therefore not surprising that physicists, engineers and climatologists have sought understanding of the physical components of heat stress, and that the consequences of exposures to heat have been examined extensively by physiologists and psychologists. For many situations, the magnitude of environmental heat load on man can now be determined, and the consequences of exposure can be predicted. However, there is yet no really satisfactory system for grading heat stress in terms of the probable strains or consequences of exposure.

To qualify as satisfactory a system would have to be simple both to employ and to comprehend, yet would have to take into consideration all determining basic factors. The difficulty lies in the large number of such factors. Thirteen are listed as follows:

Factors determining imposed stress are: (*a*) air temperature; (*b*) temperature of solid surroundings (walls); (*c*) temperature of the skin; (*d*) vapor pressure at the skin; (*e*) environmental vapor pressure; (*f*) air speed; (*g*) body heat production; (*h*) body surface area and postural attitude; and (*i*) clothing.

Factors determining resulting strains are: (*a*) capacity for circulation of blood to the skin and bodily consequences of such circulation; (*b*) capacity for maintaining a wetted skin by sweating and bodily consequence of such sweating; (*c*) tolerance for elevation of body temperature and bodily consequences of such elevation; (*d*) duration of exposure.

It is obvious that a simple system of grading heat stress in terms of resulting strain cannot treat all of these items as separate variables. The problem is, then, to find and relate the primary determining variables, and to fix the others or eliminate them from consideration.

In the light of these considerations, it seems appropriate to examine the adequacy of the best available systems of grading heat. The first is the widely used system of effective temperatures developed by the ASHAE. From the physiologist's point of view, it seems remarkable that the effective temperature scales, based on immediate psychological reactions as to thermal equivalence of different environments, should so well predict combinations of conditions which result in equivalent long-term physiological effects. The principal deficiencies of these scales are: (1) that higher levels of body heat production are not covered; (2) that the meaning of the units of the scales in terms of physiological strains is not apparent; and (3) the scale units do not indicate equal increments of physiological strain. This last is because they are based empirically on equal units of temperature of saturated air.

A second system of grading, the *Probable Four Hour Sweat Rate* (P4SR) of McArdle[1] et al, is less well known, but comes closer to meeting the requirements for a scale which indicates stress in physiological terms. Its main disadvantages are that it too is empirically constructed and that the significance of its units in terms of physiological strain is not obvious.

This communication is devoted to the propositions (*1*) that values for components of heat stress can be rationally combined in a way which will predict the physiological strain resulting from an exposure, and (*2*) that a simple scale constructed in accordance with this relationship will be easier to interpret and to use than the empirically designed scales that are presently available.

The aim is to provide an index of heat stress based on strains predicted to result from exposure. The approach is: (1) to provide a means for evaluating the components of heat stress of any environment; (2) to determine what, if any, systematic

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[1]Exponent numerals refer to References.

relationship exists between these components of stress and the resulting physiological strains; (3) to assign to the stresses index values which have meaning in terms of human endurance for heat.

Evaluation of Components of Heat Stress

Man is a homeotherm, *i.e.*, he maintains a constant body temperature. This implies that he has mechanisms which operate, within their capacities, to maintain a balance between heat production and dissipation. Under conditions of ordinary thermal *comfort*,

$$M + R + C \cong 0‡ \quad \text{.....(1)}$$

where

M = bodily heat production resulting from metabolism.
R = radiation gain by the body.
C = convective gain.

Since M is always positive, $R + C$ must be negative by an equal amount. R and C are maintained in balance with M by vasomotor adjustment of blood flow to the skin.

Heat stress is considered to exist whenever, despite vasomotor adjustment, metabolic heat production exceeds the combined losses by radiation and convection; in other words, when $M + R + C$ gives a positive value.

Heat Load: It follows that the primary component of heat stress is the load which must be dissipated by means other than R and C if heat balance is to be maintained. The available *other means* is the secretion and evaporation of sweat. Therefore, the load may be expressed in terms of evaporation required for heat balance, E_{req}.

$$M + R + C = E_{req}$$

Determination of heat load, E_{req}, depends on adequate estimates of M, R and C. Under many circumstances, these estimates can be made. The metabolic cost, M, of many kinds of activity has been reported in studies scattered through the physiological literature,[2,3] and coefficients of heat transfer by R and C have been established for man.

M values for various representative types of activity have been assembled in Table 1.

Haines and Hatch[4] have recently provided a quick means for separately estimating R and C for an average-sized nude man with a skin temperature of 95 F, based only on knowledge of air temperature, globe temperature and air speed. The coefficients were obtained from work of Nelson et al[5] at Fort Knox. The separate values in Btu per hr may be approximately determined from

$$R = 22\ (t_w - 95)* \quad \text{.....(2)}$$

$$C = 2\ \sqrt{V}\ (t_a - 95) \quad \text{.....(3)}$$

where

t_w = mean temperature of the solid surroundings (walls).
t_a = ambient temperature.
V = air speed in feet per minute.

The sum of $R + C$ may also be obtained directly from the globe temperature and the air speed, as in chart A of Fig. 1. This assumes that the globe temperature represents the weighted average of the wall and air temperatures, in accordance with the following equations:

$$R + C = (22 + 2\sqrt{V})(t_g - 95) \quad \text{..(4)}$$

and

$$t_g = (k_r t_w + k_c \sqrt{V} t_a)/(k_r + k_c \sqrt{V}) \quad \text{.....(5)}$$

The assumption is in error in proportion to the differences in value of the heat transfer coefficients for man and globe. Fortunately, the radiation difference compensates for the convection difference and the value of $R + C$ obtained from chart A agrees within 5 percent with the sum of the separately calculated values. Total heat load, $M + R + C = E_{req}$, is found by entering chart B of Fig. 1.

When heat load is estimated by this method, four of the applicable factors determining imposed stress are used as determining variables, three are fixed.

One of the fixed items is body surface area, at 20.0 sq ft (applicable for a man about 5 ft 8 in. tall who weighs 154 lb). Actually, a small man is less stressed than a large one, and a thin man less than a fat one because of differences in heat production and surface area and the ratio between the two.

The second fixed item is skin temperature. Under different hot conditions endurable for prolonged periods, mean skin temperature has been found to lie between extremes of about 94 and 98 F. Actually, temperatures of 96 or 97 F are probably more representative of fairly severe conditions than the 95 F used by Haines and Hatch[4]. The 95 F value is used here since it is applicable for many conditions of moderate stress and since the resulting overestimate of stress under severe conditions will compensate in part for the underestimate resulting from use of this system on clothed men.

Clothing is the third variable fixed for the estimate, and it is unfor-

‡Strictly, $M + R + C + E_{insens} \cong 0$, where E_{insens} is the 50 to 100 Btu per hour of *insensible perspiration* which is lost by evaporation of moisture put into the breath and diffused through the skin. E_{insens} is neglected in this treatment.

*Use of this rather than the true fourth power relationship for heat transfer between walls and man will result in an error in estimating R of not more than 50 Btu per hr, unless wall temperature exceeds 175 F. T_w is calculated from globe temperature (T_g), air temperature and air speed, as follows:

$$T_w = \sqrt[4]{T_g^4 + (0.103 \times 10^9 \sqrt{V})(T_g - T_a)}$$

Table 1—Estimates of Energy Metabolism (M) of Various Types of Activity *(Values apply for a 154-lb man, and do not include rest pauses)*

		M Btu/hr
	Sleeping	250
	Sitting Quietly	400
LIGHT WORK	Sitting, moderate arm and trunk movements (*e.g.*, desk work, typing)	450-550
	Sitting, moderate arm and leg movements (*e.g.*, playing organ, driving car in traffic)	550-650
	Standing, light work at machine or bench, mostly arms	550-650
MODERATE WORK	Sitting, heavy arm and leg movements	650-800
	Standing, light work at machine or bench, some walking about	650-750
	Standing, moderate work at machine or bench, some walking about	750-1000
	Walking about, with moderate lifting or pushing	1000-1400
HEAVY WORK	Intermittent heavy lifting, pushing or pulling (*e.g.*, pick and shovel work)	1500-2000
	Hardest sustained work	2000-2400

tunate that limitations of available knowledge make it necessary to fix on a no-clothing basis. Since clothing acts as a thermal barrier between the skin and environment, estimates of load may be seriously in error if heavy clothing is worn. For single layers of light weight clothing, it is probable that the resulting underestimate of load below air and wall temperature of 95 F and the overestimate above will not represent serious errors.

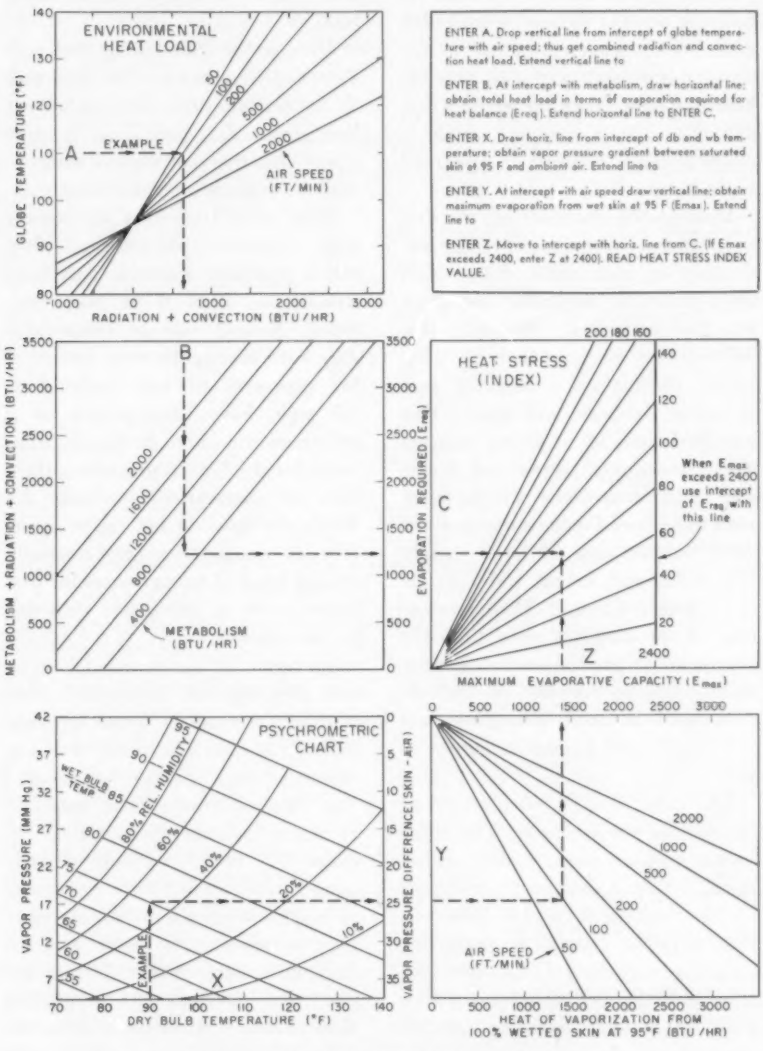
ENVIRONMENTAL HEAT LOAD
GLOBE TEMPERATURE (°F)
RADIATION + CONVECTION (BTU/HR)
EXAMPLE
AIR SPEED (FT/MIN)
ENTER A. Drop vertical line from intercept of globe temperature with air speed; thus get combined radiation and convection heat load. Extend vertical line to
ENTER B. At intercept with metabolism, draw horizontal line; obtain total heat load in terms of evaporation required for heat balance (Ereq). Extend horizontal line to ENTER C.
ENTER X. Draw horiz. line from intercept of db and wb temperature; obtain vapor pressure gradient between saturated skin at 95 F and ambient air. Extend line to
ENTER Y. At intercept with air speed draw vertical line; obtain maximum evaporation from wet skin at 95 F (Emax). Extend line to
ENTER Z. Move to intercept with horiz. line from C. (If Emax exceeds 2400, enter Z at 2400). READ HEAT STRESS INDEX VALUE.
METABOLISM + RADIATION + CONVECTION (BTU/HR)
METABOLISM (BTU/HR)
EVAPORATION REQUIRED (Ereq)
HEAT STRESS (INDEX)
When Emax exceeds 2400 use intercept of Ereq with this line
MAXIMUM EVAPORATIVE CAPACITY (Emax)
PSYCHROMETRIC CHART
WET BULB TEMP
% REL. HUMIDITY
VAPOR PRESSURE (MM Hg)
DRY BULB TEMPERATURE (°F)
VAPOR PRESSURE DIFFERENCE (SKIN - AIR)
HEAT OF VAPORIZATION FROM 100% WETTED SKIN AT 95°F (BTU/HR)

Fig. 1—Flow charts for determining heat stress index values

Example: Globe 110, dry bulb 90, wet bulb 75, air speed 100, metabolism 600 (light arm work standing at bench). For solution follow broken lines: Heat stress = 90.

Heat Acceptance of the Environment: The other component of heat stress is the resistance of the environment to actual evaporation of the sweat required for thermal balance, E_{req}. This component is also secondary in that it does not affect the heat load, but does affect its dissipation.

The capacity of the environment to accept the load depends on the vapor pressure gradient between the skin and air, and on the air speed. Haines and Hatch[4] have also provided a simple method for estimating maximum evaporative capacity, E_{max}, again on the basis of constants from the Fort Knox studies, and under the conditions listed above, with the added assumption that the skin is everywhere maintained wet and is at 95 F (skin vapor pressure, 42 mm Hg). Here,

$$E_{max} = 10.3\ v^{0.6}\ (42 - VP_a) \quad \ldots(6)$$

where

VP_a = the vapor pressure of the air in millimeters of mercury.

When dry- and wet-bulb temperatures and air speed are known, E_{max} may be determined from charts X and Y of Fig. 1.

If a man were an automaton with unlimited sweat-producing capacity, it would now be reasonable to specify that heat stress of a situation is proportional to E_{req} up to the point where E_{req} exceeds E_{max}. It would then follow that beyond this point the stress is excessive in proportion to the amount by which E_{req} exceeds E_{max}. This criterion of stress is not justified for the simple reason that man is not a sweating automaton[6]. He does within wide limits produce sweat in an amount appropriate for maintaining approximate heat balance. But his capacity for sweating is limited, and the cooling efficiency of the sweat that is produced is known to decrease as E_{req} approaches E_{max}.

Evaluation of Heat Strain

The next part of the problem is to find what relationship exists between physiological heat strain, and values for E_{req} and E_{max}.

While there are many manifestations of heat strain, including thirst, increased blood volume, sensation of fatigue or faintness, and rising body temperature, most are dependent on the two primary strains which are directly operative for removal of heat.

The first primary strain resulting from heat stress is marked increase in circulation of blood to the skin. This brings internal heat to the skin; it also raises skin temperature, thereby increasing the temperature (and potential vapor pressure) gradient between skin and the environment. Secondary manifestations of this strain are increased heart rate, flushing of the skin, faintness and perhaps lassitude, any or all of which

may be related to the diversion of blood supply from the body core to the skin. Evidence exists that for fit persons this strain is limiting only when the sweat that is secreted cannot be evaporated. For persons with impaired cardiovascular function, however, this strain will frequently determine endurance for heat.

The second primary strain is the production of sweat. To the extent that such sweat is evaporated (with the removal of approximately 1050 Btu per lb) this is a useful physiological response. Some secondary manifestations of the operation of the sweating mechanism are thirst, salt depletion (sometimes leading to cramps), and heat rash.

On the basis of these considerations, it is not surprising that heart rate, sweat rate, rectal temperature and skin temperature show significant correlations with environmental heat stress. Increased heart rate and skin temperature† are indirect reflections of the first primary strain. Both of these and rectal temperature may be indirect manifestations of failure to maintain bodily heat balance, as a consequence of high heat stress. But *sweat rate is itself one of the primary manifestations of heat strain,* as indicated above. In view both of the direct role of sweat in meeting E_{req}, and of the effectiveness with which body temperature is maintained at a *normal* level during exposure to heat, it is not surprising that sweating shows the highest separate correlation with presumed stress, as measured by Effective Temperature□. This point has been made by Wyndham et al[7].

The assumptions on which this heat stress index is constructed are: (1) that sweat rate is an adequate index of overall heat strain; (2) that sweating is proportional to imposed heat stress; and therefore (3) that heat strain can be represented in terms of heat stress. There is precedent for the first assumption in that the sweat rate was accepted as evidence of strain by McArdle et al in developing P4SR[1].

Index of Heat Strain: The tasks remaining are (1) to provide an index scale which relates sweating to endurance for heat, and (2) to combine the two items of stress, E_{req} and E_{max}, in a manner which is systematically related to observed sweat rates.

Upon initial examination, the first task seemed impossible, because endurance of individuals differs with their structural attributes and physiological capacities. However, this difficulty is circumvented by arbitrarily designating a *standard man* to whom the scale will apply. This *standard man* is a young man of above average physique and fitness and with dimensions which agree with those used for the stress analysis (*e.g.*, surface area 20 sq ft, height 5 ft 8 in. and weight 154 lb); he is acclimatized to heat. This specification of the *standard man* probably represents as good a general description as can be provided of the subjects used in most laboratory and field studies of human responses to heat.

The index is to be based on sweating of this *standard man.* The index values will be most readily understood if they represent a percentage of his sweating capacity. However, this requires setting a value for sweating capacity of the *standard man,* and thereby introduces a new difficulty, because sweating capacity depends on duration of exposure. This is indicated by representative average values for maximum sweat rate taken from the literature[6] and plotted in Fig. 2. Apparently, some men can sweat at a rate of well above two liters per hour for brief periods, and between 1½ and 2 liters for four hours, but over a 24-hr period the average rate has not exceeded about half a liter per hour.

The most useful period upon which to specify sweating capacity would seem to be the normal work day of 8 hr, and a good approximation of capacity for that period seems to be 1 liter of sweat per hour (Fig. 2). *The index value* 100 *is therefore specified to represent a sweat rate of* 1 *liter per hour.* Evaporation of a liter of sweat requires about 2400 Btu.

Meaning of Heat Strain Index in Terms of Heat Stress: The final task is to combine the two factors of heat stress, E_{req} and E_{max}, in such a way that they correspond with observed sweating for a standard man.

Heat Stress 100: As a preliminary step, extensive physiological data which represent *tolerable* maximum strains for 4 to 6 hr were collected. Several sets of comparable data were found; the most extensive, for exposures of men walking at 3.5 mph, have been plotted on a psychrometric chart as Fig. 3. (The bases for the lines representing these data are summarized in Table 2.) While the lines do not superimpose, they do designate a physiologically critical band of temperatures for prolonged work of this grade with this air movement*.

In terms of environmental stress and physiological knowledge, what rational basis can be found for these limits? In the first place, for any prolonged task it may be assumed that the participant must maintain or nearly maintain heat balance, because any large elevation of body temperature (more than a degree or two above normal for any activity) may be expected to result in a decrement in performance. This means that the environmental conditions must permit evaporation of whatever sweat is required to maintain heat balance; *i.e.*, E_{req} may equal, but must not exceed, E_{max}. The heavy broken line of Fig. 3 indicates, for the applicable conditions of work and air movement, the locus of points where E_{req} is predicted to just equal E_{max}. The actual value of $E_{req} = E_{max}$ increases as the vapor pressure (or relative humidity) de-

†Skin temperature is also affected by the net rate of heat *removal,* by radiation, convection and evaporation.

□Combinations of these interrelated factors yield higher correlations. Robinson[8] has proposed an *Index of Physiological Effect* which combines all four of the manifestations of strain that have just been considered.

*The *difficult* line from the Fort Knox studies may well be judged not comparable on the basis that half of the subjects were just able to complete four hours under this condition. If this line is disregarded, the limiting conditions for prolonged work are more narrowly defined.

creases, from about 800 Btu at 87 F and vapor pressure 32 mm Hg (100 percent RH) to 3400 Btu at 136 F and zero vapor pressure (0 percent RH).

However, in line with previous considerations, an E_{req} value of 2400 (1 liter of sweat per hour) must not be exceeded because this value represents sweating capacity of the *standard man* for an 8-hr period. For this reason the limit line for these particular conditions becomes fixed at a dry-bulb temperature of 118 F (dotted line) and is not continued to intercept at 136 F. McArdle's predictions lend support to the physiological postulate that when E_{max} is not limiting, the heat load, E_{req}, becomes determining.

The broken line indicating $E_{req} = E_{max}$ does not superimpose on the observed limits, but calculations show that it lies below the other lines only because a skin temperature of 95 F was assumed instead of the 97 or 98 F usually observed by physiologists under such conditions. Examination of the limit lines of Robinson and of McArdle and associates for men clothed in coveralls indicates an even better correspondence with the theoretical boundary lines derived on the basis of these physiological assumptions.

Data have been plotted here for only one grade of work and one wind velocity, but investigation using this same approach has been extended to conditions of light work and of rest. While the physiological data on these is not as extensive as for the grade of work treated here, the relationship of predicted limits to actual data on tolerance is generally similar to that just presented for moderate work. (The actual values are, of course, quite different.)

For this index, the limit lines calculated on the basis of stress are accepted as consistent with a probable strain of 100 for the *standard man*, despite the fact that the limits indicated by physiological investigation on nude men lie somewhat higher. The physiological experiments represented results of 4 to 6 hr exposures rather than the 8 hr specified for the *standard man*, and civilized man usually wears a light covering of clothing, the net effect of which usually is some increase in heat strain.

In summary, a heat stress value of 100 is assigned when $E_{req} = E_{max}$, or when E_{req} equals 2400 Btu per hr. The positions of stress-100 lines for three different grades of activity and at three air speeds are shown in Fig. 4.

Heat Stress Less Than 100: In the first tentative proposal of a heat stress index by the authors[10], stress

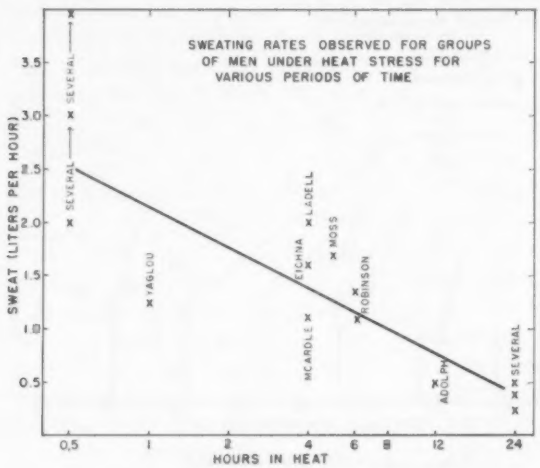

Fig. 2—Average sweating rates of men under heat stress for various periods of time

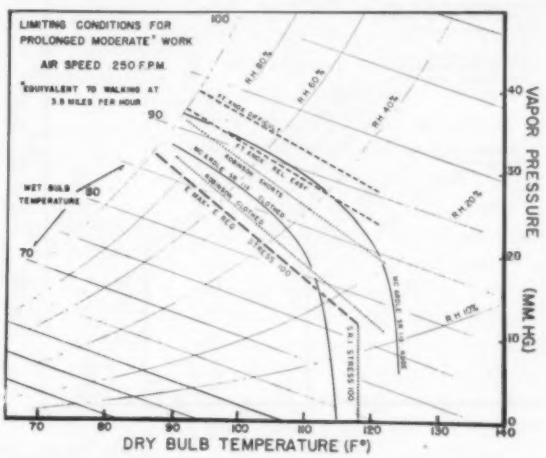
LIMITING CONDITIONS FOR PROLONGED MODERATE* WORK
AIR SPEED 250 F.P.M.
*EQUIVALENT TO WALKING AT 3.5 MILES PER HOUR
WET BULB TEMPERATURE
VAPOR PRESSURE (MM HG)
DRY BULB TEMPERATURE (F°)

Fig. 3—Limiting conditions for prolonged moderate work

Table 2—Key to Fig. 3 *(Limiting Conditions for Prolonged Moderate Work)*

Designation in Fig. 3	Conditions	Reference No.
ROBINSON SHORTS	Walking on treadmill dressed only in shorts; metabolic rate 188 calories per (square meter) (hour); air movement 55 m/min. These represent the most severe environmental conditions in which men maintained thermal equilibrium from second through sixth hours of exposure.	8
ROBINSON CLOTHED	Ditto above, but metabolic rate 189 calories per (square meter) (hour). Subject dressed in herringbone twill jungle uniform	8
FT. KNOX REL. EASY	Continuous marching for 4 hr at 3 mph with 20 lb pack; (300 calories per hour) no clothes except shoes and socks. Men finished *fit to fight* with average skin temperatures 95.5 to 100.2 F; rectal temperature 100.1 to 101.2 F; and heart rate 121 to 150 beats per min.	9
FT. KNOX DIFFICULT	Ditto above; the less fit subjects were barely able to finish the four hours.	9
MCARDLE S.R. 1.13 NUDE	Based on extensive hot room studies, the curve shows predicted conditions under which a nude man will sweat 4.5 liters in 4 hr of exposure (1.13 liters per hour). This is the highest sweat rate at which every subject was able to complete 4 hr; metabolic rate 165 calories per (square meter) (hour); men nude.	1
MCARDLE S.R. 1.13 CLOTHED	Ditto above, but prediction is for men wearing overalls over underwear shorts.	1
$E_{max} = E_{req}$ STRESS 100 (BROKEN LINE)	At all points on this line, evaporation rate from wet skin at 95 F with air speed 250 fpm (from Haines and Hatch, Fig. 9) is just equal to the total heat load arising from metabolism, radiation and convection (Haines & Hatch, Table 1, Figs. 5 and 6.)	4
SR 1 L. STRESS 100	This denotes conditions under which heat balance may be maintained with a sweat rate of 1 liter per hour.	This Communication

values less than 100 were assigned on the basis of E_{req} (*i.e.*, $E_{req}/2400 \times 100$ = stress) up to the point where $E_{req} = E_{max}$ (*i.e.*, index 100 as defined above). However, it was found that this procedure failed to take into account the physiological sweat only suffices to maintain heat balance; rather it must be regarded as a progressive inefficiency of evaporation. The reason for this is not clear, but since the cooling is not that predicted for complete evaporation of all of the formed sweat at the skin, it may be assumed that some drips off due to inefficient distribution of sweating activity over the body surface, or that the sweat that indicated by E_{req} alone. The heavy broken lines of Fig. 5 have been constructed on this basis:

$$(E_{req}/E_{max}) \times 100 = \text{index} \quad \ldots\ldots(7)$$

whereas the dotted lines indicate stress determined on the basis of the maximum sweating capacity.

The higher index values constructed on this basis lie below the corresponding observations on nude

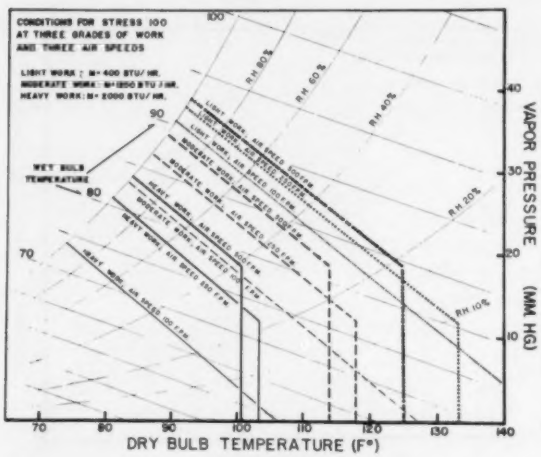

Fig. 4—Conditions for stress 100 at three grades of work and three air speeds

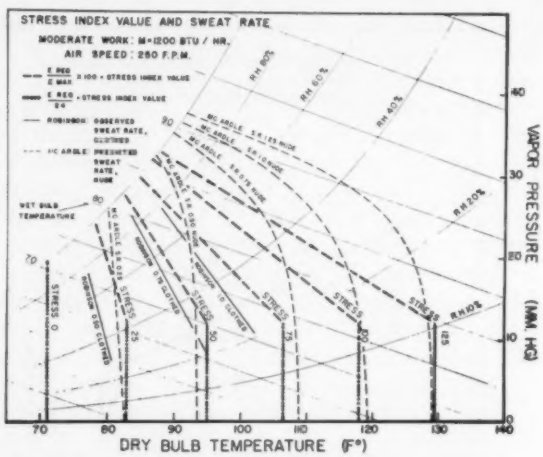

Fig. 5—Stress index value and sweat rate

observation that the evaporation limits often are a factor in strain even when E_{req} lies below E_{max}. This is indicated in Fig. 5 by the slope of McArdle's[1] lines for predicted sweat and Robinson's[8] for observed sweat at levels of 0.25, 0.50 and 0.75 liters per hour. In physiological terms, as E_{req} approaches E_{max} more sweat is secreted than is theoretically needed for heat balance. This does not represent *oversweating*, because the extra is evaporated at some distance from the skin (as from the top of droplets). Gagge[11] introduced a concept of *wetted area* in relation to this inefficiency and accompanying sensation of discomfort.

A simple way of improving the fit of the lines of equal stress with observed sweat rates is to consider the stress proportional to the ratio between E_{req} and E_{max} up to the point where this ratio is less than

Table 3—Analysis of Heat Stress of Three Jobs in Terms of Physiological Strain

Description of Job		Job #1 Transfer operator at glass forming machine	Job #2 Inspector at glass forming machine	Job #3 Miners; deep mine
Globe temperature, F deg		130	104	93
Air temperature, F deg		100	90	88
Wet-bulb temperature (F deg)	Summer	80	75	88
	Winter	60	58	88
Air speed (ft/min)		200	200	200
Radiation and Convection (Btu/hr)		1800	500	−100
Metabolism (Btu/hr)		1000	600	700[a]
E_{req} (Btu/hr)		2800	1100	650
E_{max} (Btu/hr)	Summer	1700	1800	650
	Winter	2900	2900	650
Raw Index of heat stress	Summer	175	60	100
	Winter	120	45	100
Percent time in heat		50	80	100
Index of total job heat stress	Summer	88	48	100
	Winter	60	36	100

[a]Includes rest pauses; hypothetical case constructed from Wyndham et al[11].

men apparently for the same reason that they did for stress 100 (*i.e.*, skin temperature of 95 F is used in computing the stress). The lower index values correspond better, perhaps because the 95 F skin temperature assumed in computing the stress is close to that actually observed under such conditions of exposure.

On the basis of the above considerations, heat stress index values are computed on the basis of $(E_{req}/E_{max}) \times 100$ whenever this yields a higher value than that obtained by using $(E_{req}/2400) \times 100$.

Heat Stress Greater Than 100: The same system may be used for determining and stating stresses greater than 100. Here, when E_{max} is less than 2400, the index is $(E_{req}/E_{max}) \times 100$. When E_{max} exceeds 2400 the index is $(E_{req}/2400) \times 100$.

When heat stress exceeds 100 the implication is that heat balance may not be maintained and that the sweating mechanism may be overtaxed, so that the *standard man* will not tolerate prolonged exposure. Such

conditions are actually found in some industrial jobs and during hard work in hot weather. The overall stress under such circumstances will be indicated by the stress index, and the maximum endurance of a single exposure will depend on the worker's tolerance to elevated body temperature. On the basis of physiological studies, it seems likely that the *standard man* may safely tolerate an elevation of body temperature of 2 F, and for him this represents an accumulation in the body of about 250 Btu of stored heat. His maximum tolerance time for a single exposure might then be calculated by using Equation 8:

$$250/(E_{req} - x) = \text{maximum allowable exposure in hours} \quad (8)$$

where

x = 2400 or E_{max}, whichever is smaller.

Minimum allowable time for recovery depends on the amount of heat stored in the body as well as on environmental conditions and bodily activity during the recovery period. On these bases, the minimum time (in hours) for recovery might be represented by:

$$\frac{H_{stored}}{H_{sweat} - E_{req\ recov}}$$

in which

H_{stored} = amount of heat stored.
H_{sweat} = maximum heat removal by sweating.
$E_{req\ recov}$ = E_{req} of recovery environment.

Maximum heat removal by sweating might be given the value 2400, or E_{max} of the recovery environment, whichever is less. E_{req} *of recovery environment* might, of course, be a negative figure if the environmental conditions were cool enough.

Since there have been few physiological studies of tolerance times and of the recovery process within the stress range that is of interest, the validity of these procedures is questionable.

Determination of Heat Stress (Index Value): Fig. 1 has already been introduced as a method for evaluating heat load (charts A and B) in terms of E_{req}, and of maximum evaporative capacity (charts X and Y), E_{max}. If the remaining chart is now entered at C and Z the intercept will indicate the applicable heat stress index value.

Examples: Work sheets applicable to three different jobs are summarized in Table 3. The first two have been somewhat simplified in that radiant and convective heat loads have been considered the same in summer and winter. In reality the air temperature is somewhat lower in winter and higher in summer than the value given, but the significantly lower stress in winter is largely accounted for by the lower vapor pressure and consequent greater evaporative capacity of the air.

The first example cited represents a very severe exposure to radiant heat where two men customarily work in rotation on the job.

The second example represents a job requiring little physical effort; in some jobs of this type a 10- or 12-min rest break is allowed each hour.

Table 4—Evaluation of Index of Heat Stress

Index of Heat Stress	Physiological and Hygienic Implications of 8-Hr Exposures to Various Heat Stresses
−20	Mild cold strain. This condition frequently exists in areas where men recover from exposure
−10	to heat.
0	No thermal strain.
+10	Mild to moderate heat strain. Where a job involves higher intellectual functions, dexterity,
20	or alertness, subtle to substantial decrements in performance may be expected. In performance
30	of heavy physical work, little decrement expected unless ability of individuals to perform such work under no thermal stress is marginal.
40	Severe heat strain, involving a threat to health unless men are physically fit. Break-in period required for men not previously acclimatized. Some decrement in performance of physical
50	work is to be expected. Medical selection of personnel desirable because these conditions are
60	unsuitable for those with cardiovascular or respiratory impairment or with chronic dermatitis. These working conditions are also unsuitable for activities requiring sustained mental effort.
70	Very severe heat strain. Only a small percentage of the population may be expected to qualify for this work. Personnel should be selected (*a*) by medical examination, and (*b*) by trial on
80	the job (after acclimatization). Special measures are needed to assure adequate water and
90	salt intake. Amelioration of working conditions by any feasible means is highly desirable, and may be expected to decrease the health hazard while increasing efficiency on the job. Slight "indisposition" which in most jobs would be insufficient to affect performance may render workers unfit for this exposure.
100	The maximum strain tolerated daily by fit, acclimatized young men.

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The third example, that of the miner, is partly hypothetical and represents about the worst conditions at which physiologists have found that acclimatized laborers can work steadily at a moderate pace[12]. Without extensive supply of fresh air by forced ventilation, the heat stress would be much worse because the walls would then attain a temperature as high as 120 F, and the air temperature would approach that of the walls; such conditions cannot be tolerated long even by resting men.

If exposures are intermittent or a job is varied, there may be justification for averaging the stresses (*e.g.*, Table 3). For example, a man in a glass factory works under a stress of 70 for 3 hr, 20 for 2 hr, and escapes completely from exposure for one hour; it may be fair to express his overall heat stress as

$$[(70 \times 3) + (20 \times 2)]/6 \cong 42 \quad \ldots\ldots (9)$$

Since the standard 6-hr day in the glass industry represents recognition of exposure to heat stress, it might even be considered legitimate to use 8 hr in the denominator, which would yield a daily stress average of 31. The caution in interpretation in this case derives from the fact that some persons able to tolerate a 31 stress if it represented 8 hr of light work might not be able to tolerate the 3 hr of stress 70. This might be particularly true if the 70 exposure represented heavy muscular work, because the heat production, but not the accompanying physical strain, of work is represented by the index.

Significance of Different Index Values: While the principal purpose of this communication is to propose a means for evaluating stress in terms of the *standard man*, rather than to discuss the strains of exposures on people with different physical attributes, some interpretation of the stress figures in terms of strains on workers seems desirable. Table 4 represents an attempt to summarize some implications of daily exposures to various heat stresses in terms of

present general understanding of heat effects.

Interpretations must be made with caution. If the subject is a woman or child, is elderly, suffers circulatory or respiratory impairment, or is not acclimatized, the index values have an absolute meaning different from that for the *standard man* even though the relative meaning may be the same. Heat exposures result in more strain on large and overweight persons, basically because the amount of their skin surface (through which the heat must be lost) is relatively small in relation to their mass (which produces the heat).

The competence of different individuals to withstand any type of stress undoubtedly follows the *normal distribution curve*. If a required production of 1 liter of sweat per hour for 6 or 8 hr a day on several days a week is just tolerable for our young, physically above average, acclimatized *standard man*, it seems likely that no more than 10 to 20 percent of the working population could be expected to work successfully under a stress of 100. It is also reasonable to suppose that almost all of the working population could successfully withstand strains given by index rating 10, 20 and 30, and termed *moderate*. A majority of the population should withstand 40, 50 and 60, the stresses that have been categorized *severe*. It is notable that the ability to withstand heat stress decreases with age, and that this may be related to progressive impairment of cardiovascular function. Since cardiovascular functional capabilities of women are less, even for their size, and since there is somewhat greater insulation in the skin of women it seems probable that the heat strain for women corresponding to any given stress is somewhat more severe than is indicated by this index. However, these points require verification.

There is considerable evidence that prolonged mild heat stress (Indexes 10 to 30) affects alertness and drive, and may subtly affect performance of higher intellectual functions. On the other hand, there seems to be little decrement in the performance of moderate to heavy physical work under such conditions unless the ability to perform such work is marginal under conditions of no thermal stress. Conditions of prolonged *severe* heat stress (Indexes 40 to 60) seem unsuited for activities requiring sustained mental effort, but may not affect physical effort of men who are physically fit and have been acclimatized. Under conditions of prolonged *very severe* heat stress (Indexes 70 to 100) performance of physical work may be markedly impaired even though the men involved suffer no obvious deleterious aftereffects from exposures.

Applications of Stress Index to Practical Problems

It is believed that the method described here is unique in that it yields a single figure descriptive of the overall heat stress involved in an exposure — a figure which is quantitatively comparable with similarly derived index figures for other exposure conditions.

The index may be of value whereever there is need to describe hot conditions and wherever there are problems related to heat exposure. The climatologist and geographer (and even the U. S. Weather Bureau) might find it useful to describe hot weather; the only need would be to fix a *standard activity* for the *standard man*.

Air conditioning engineers, military command and medical personnel, industrial hygienists, methods engineers and physicians may wish to use it on such problems as: (1) regulating work of men in hot climates; (2) predicting heat danger to those engaged in out-of-door tasks where solar radiation is a factor; (3) selection and assignment of persons fit to withstand heat stress; (4) reaching decisions regarding the relative need for remedial action, either to improve an environment or lighten the work required in an environment; (5) determining on a rational basis maximum allowable time of single exposures; (6) specifying hygienically desirable conditions for recovery following exposure to heat; (7) surveys of populational exposure to heat; (8) providing a basis for arbitration of pay bonuses for hot jobs.

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10. Evaluation of Physiological Strain on Hot Jobs, by H. S. Belding and T. F. Hatch. (Proceedings of Fourth Annual Conference, *Ergonomics Research Society*, England).

11. A New Physiological Variable Associated with Sensible and Insensible Perspiration, by A. P. Gagge. (*American Journal of Physiology*, Vol. 120, 1937, p. 277).

12. Practical Aspects of Recent Physiological Studies in Witwatersrand Gold Mines, by C. H. Wyndham, W. Van Der Merwe Bouwer, H. E. Paterson and M. G. Devine. (*Journal of Chemical, Metallurgical and Mining Society of South Africa*, April 1953, p. 287).

Golden Gate Meeting Attracts Record Throng

Three Technical Sessions and Symposium on Evaporative Cooling and Proposals for By-Law Changes feature 1955 Semi-Annual Meeting in San Francisco

Meeting at San Francisco for the first time since 1941, the Society held the 1955 Semi-Annual Meeting at the St. Francis Hotel, June 27-29, attracting a total attendance of 662. Final figures show that 335 members, 179 ladies, 123 guests and 25 children were present. With San Francisco such a famed point of departure for vacation spots, many took advantage of the opportunity and came from 34 states, besides one member each from Denmark and South Africa.

All of the three technical sessions as well as the Evaporative Cooling Symposium were well attended, while the Council meeting preceding the formal opening, and the meetings of technical and general committees attracted the attention of many of those in attendance.

The success of the meeting was largely due to the untiring work of all the members of the Committee on Arrangements of the Golden Gate Chapter, under General Chairman S. W. Terry, Vice Chairman H. L. Duncan, Honorary Chairman G. M. Simonson, and the special sub-committees, each headed by its own chairman, *viz*: *Banquet* — N. H. Peterson; *Entertainment* — J. I. Sprott; *Finance* — K. F. Baldwin; *Ladies* — E. C. Cooley, Jr.; *Publicity* — T. E. Brewer; *Reception* — T. J. White; *Sessions* — D. L. Williams; *Sports* — Dudley Deane; *Transportation* — K. K. LaPoint; *Young People's* — R. C. Pribuss.

Dr. H. B. Nottage, vice chairman, and Pres. John E. Haines, presiding officer, shown before opening of first technical session of the 1955 Semi-Annual Meeting

First Technical Session, Monday, June 27, 9:30 a.m.

Following the opening of the session in the Italian Room of the St. Francis Hotel, Pres. John E. Haines, Minneapolis, Minn., presented D. E. McLeod, president of the Golden Gate Chapter, who expressed his own pleasure, and that of the chapter, on being able to welcome the Society to San Francisco after the 14 years which have elapsed since the 1941 meeting.

In reply, President Haines expressed the pleasure of the Society at the opportunity of meeting in San Francisco.

President Haines announced that the next order of business would be the presentation of the proposed By-Laws. He read the section of the By-Laws outlining the method of amending them and explained that the proposed By-Laws were presented only at this session and that discussion and action on them would take place at the Annual Meeting in Cincinnati in January 1956. He indicated that it was hoped that members would take advantage of the period to discuss these proposed changes and be prepared to vote on them at the Annual Meeting. He then called on Second Vice Pres. P. B. Gordon, New York, N. Y., to present the changes.

Vice President Gordon presented to the meeting a written notice of proposed amendments to the Society By-Laws. The statement set forth that it was proposed to amend *ARTICLE II, Memberships*, and specified the sections to be amended and the detailed wording of the amendments proposed. In the same way, the statement presented amendments proposed to *ARTICLES III, IV, V, VII*, and *VIII*. The statement also proposed that Appendix A of the By-Laws be eliminated.

Vice President Gordon outlined the meaning of the several effects these amendments could be expected to have. He also stated that the amendments were proposed by the Council and were endorsed by more than two-thirds of the Council members.

Major General William F. Dean speaking on "Military Requirements of Today" at Welcome Luncheon. Seated *(l. to r.)* C. E. Bentley, toastmaster, G. M. Simonson, chairman, Pres. John E. Haines, S. W. Terry, general chairman, Committee on Arrangements, Second Vice Pres. P. B. Gordon

Journal Section

President Haines then appointed the following to serve as the Committee on Resolutions: John Everetts, Jr., Philadelphia, Pa., Chairman; G. C. F. Asker, Washington D. C., B. L. Evans, St. Louis, Mo., and D. M. Mills, Houston, Tex.

President Haines then turned the gavel over to H. B. Nottage, vice chairman of the first technical session. Dr. Nottage read the rules for professional sessions and called on Harry Buchberg, Los Angeles, Calif., who presented his paper, Electric Analogue Prediction of the Thermal Behavior of an Inhabitable Enclosure, (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, June 1955, pp. 131-138).

Chairman Nottage then announced that the paper, A Method for Determining Winter Design Temperatures, by M. K. Thomas, Toronto, Ont., Canada (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, May 1955, pp. 155-158) would be presented by G. O. Handegord, Saskatoon, Sask., in the absence of Mr. Thomas.

As the concluding paper of the session, D. J. Vild, Cleveland, Ohio, presented Periodic Heat Flow Through Flat Roofs, by D. J. Vild, M. L. Erickson, G. V. Parmelee and A. N. Cerny (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, July 1955, pp. 145-151). Chairman Nottage then turned the session back to President Haines, and at 12:00 noon, the session adjourned.

Second Technical Session, Tuesday, June 28, 9:30 a.m.

After opening the second session, First Vice Pres. John W. James, Chicago, Ill., presented Vice Chairman B. H. Jennings, Evanston, Ill., who presided over the session during the presentation of the technical papers.

The first paper, Ventilation of Commercial Laundries, by Sidney Marlow, New York, N. Y., (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, November 1954, pp. 149-155) was presented by E. R. Kaiser, Cleveland, Ohio.

The second paper, Air Conditioning Coil Odors, by A. B. Hubbard, Nicholas Deininger and Frederick Sullivan (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, July 1955, pp. 129-136) was presented by A. B. Hubbard, Bloomfield, N. J.

At this point Chairman Jennings turned the meeting over to First Vice President James who recognized J. S. Locke of the Minnesota Chapter.

B. H. Jennings, chairman, Committee on Research (right) accepts thousand dollar check from Minnesota Chapter presented by J. S. Locke, president of Chapter. Looking on: E. R. Kaiser, director of research; A. B. Algren, chairman, TAC on Air Cleaning

Mr. Locke expressed his pleasure at being able to present a check for $1000 to Professor Jennings for research, especially to support the air cleaning program now being carried on at the University of Minnesota. He explained that this check was authorized by the Minnesota Chapter at a recent meeting.

Jack Everetts, Jr. (*center*) and Mrs. P. B. Gordon present birthday cake to Neil H. Peterson at the "Forty-Niner Party"

Chairman Jennings expressed his pleasure at receipt of the check and pointed out that it was another example of the support which various chapters have given to the Society research work. He expressed the thanks of the Committee on Research to the Minnesota Chapter.

The third paper of the session, A Rapid General Purpose Centrifuge Sedimentation Method for Measure-

ment of Size Distribution of Small Particles, Part II — Procedures and Applications, by K. T. Whitby (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, June 1955, pp. 139-145) was presented by K. T. Whitby, Minneapolis, Minn., by title only.

Vice Chairman Jennings announced that the fourth paper, Size Distribution and Concentration of Airborne Dust, by K. T. Whitby, A. B. Algren and R. C. Jordan (see this issue, pp. 121-128) would also be presented by Dr. Whitby. Vice Chairman Jennings then announced that discussions of any of the papers could be sent to Society headquarters and would be considered for publication with each paper in the 1955 TRANSACTIONS.

Following the completion of the discussions of the papers, Vice President James adjourned the session at 12:00 noon.

Third Technical Session, Wednesday, June 29, 9:30 a.m.

Second Vice Pres. P. B. Gordon, New York, N. Y., opened the session and turned the gavel over to T. E. Taylor, Portland Ore., who read the rules for professional sessions. He then announced that Prof. W. S. Harris, Urbana, Ill., would present the paper, Sources of Vent Gas in Hot Water Heating Systems, by L. N. Montgomery and W. S. Harris (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, June 1955, pp. 125-129) in the absence of Mr. Montgomery, who is in service with the Navy.

Prof. B. H. Spurlock, Jr., Boulder, Colo., presented the paper, Psychrometric Analysis for Design of Forced Draft Cooling Towers, by S. E. Agnon and B. H. Spurlock, Jr. (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, July 1955, pp. 137-144).

Vice Chairman Taylor then announced that Dr. H. B. Nottage, Encino, Calif., would present the paper, Resistance of Wooden Louvers to Fluid Flow, by C. W. Bevier (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, May 1955, pp. 155-158) in the absence of Mr. Bevier, who is also on Navy duty.

1—Bruce L. Evans receives Eichberg Memorial Cup for the St. Louis Team

2—Pres. John E. Haines presents Past President's Memory Book to L. N. Hunter

3—Dr. A. M. Zarem speaking on "Smog" at ASHAE Semi-Annual Banquet

4—Merrill F. Blankin presents the new Past Presidents Research Bowl to R. L. Stinard, New York Chapter president, for J. E. Schechter

Journal Section

The fourth paper of the session, Performance and Evaluation of Room Air Distribution Systems, by Alfred Koestel and G. L. Tuve (published in ASHAE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, March 1955, pp. 147-154) was presented by G. L. Tuve, Cleveland, Ohio.

Vice Chairman Taylor announced that in the case of all the papers on the session program, discussions could be sent to the Society headquarters and would be considered for publication with each paper in the 1955 TRANSACTIONS.

Vice Chairman Taylor then turned the meeting over to Second Vice President Gordon and the meeting was adjourned at 11:45 a.m.

Evaporative Cooling Symposium, Wednesday, June 29, 2:00 p.m.

Treas. E. R. Queer, University Park, Pa., called the meeting to order in the Colonial Room and indicated that the subject was to be covered by a panel of eight members, each of whom was scheduled to present some particular phase of the subject.

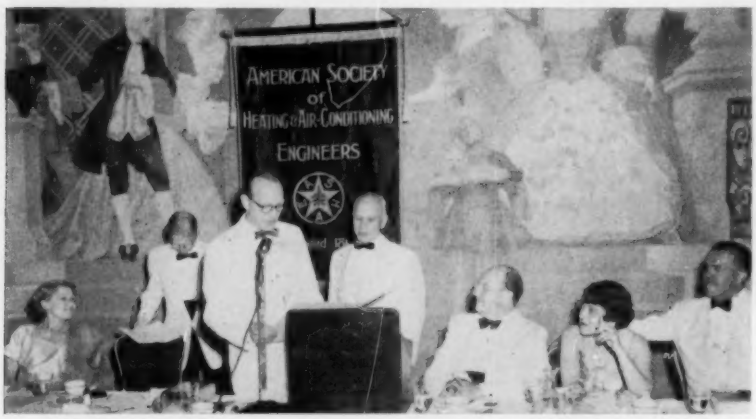
Recreation Activities

He also outlined briefly the rules of procedure and introduced Wm. T. Smith, Washington, D. C., to serve as chairman of the Symposium. Mr. Smith opened his remarks by saying that he himself had been convinced of the increasingly important position of evaporative cooling and he felt that each of the various members on the Symposium was an authority in his own right.

He then called on the various members of the Panel in order, introducing each as he did so. The several members presented their prepared remarks, an abstract of which appears in this issue on pp. 141-147. Following this presentation, the session was thrown open to discussion from the floor. These discussions are also presented in abstract form elsewhere in this issue.

Following the completion of the presentations and the discussions, Mr. Smith then turned the meeting back to President Haines who stated that the next order of business would be the Report of the Committee on Resolutions. This report was then presented by John Everetts, Jr., Chairman. Following the approval of these resolutions, President Haines then declared the session and the meeting adjourned at 4:45 p.m.

Some of the pictures taken during the San Francisco Meeting and reproduced on these pages are through the courtesy of W. M. Wallace, II, Durham, N. C.



Pres. John E. Haines presents Golden Gate Chapter Scroll to S. W. Terry

The social side of the meeting began with the welcome tea at the St. Francis on Sunday afternoon with the Sacramento Chapter acting as hosts.

At the welcome luncheon on Monday noon, nearly 300 heard Major General William F. Dean give his address on *Military Requirements of Today*.

The Monday afternoon Golf Tournament attracted 49 golfers who played the Olympic Country Club course. It developed that J. E. Schechter, New York, N. Y., won the ASHAE Past Presidents Research Bowl with a low net score of 70. The Eichberg Memorial Trophy ended up with the St. Louis Chapter whose team consisted of Bruce L. Evans, G. W. F. Myers and J. W. Cooper, with a three-man low net of 230. The Paul Bunyan Cup was awarded to J. E. Murray who had the high gross.

Also on Monday afternoon, the sightseeing trip on the bay drew a large crowd, but the *Forty-Niner* get-together party at the Surf Club, Monday evening, brought out a crowd of 400.

Tuesday's events included a morning sightseeing trip to the Muir Woods, informal dining at Fisherman's Wharf and a tour of the night clubs in the evening.

Wednesday morning was made attractive for the ladies and for the children because

Chinatown night club tour enjoyed by 75 members and guests

of the tour of the stores and for the sightseeing trip which drew attendance not only by many of the children but by the ladies as well.

The Semi-Annual Banquet held on Wednesday evening, with an attendance of 350, had Past Pres. Baldwin M. Woods, Berkeley, Calif., presiding as toastmaster. He introduced Pres. John E. Haines and other head table guests. President Haines also presented the Past President's Memory Book to L. N. Hunter. Past Pres. Merrill F. Blankin presented the ASHAE Past Presidents Research Bowl, the Eichberg Memorial Cup and the Paul Bunyan Cup.

On behalf of the Golden Gate Chapter, its Officers and Board of Governors, President Haines presented a special scroll to S. W. Terry, thanking him for his chairmanship. The Banquet address, *Smog — A Challenge to Technology*, was delivered by Dr. A. M. Zarem, manager, Southern California Division, Stanford Research Institute. Dancing in the Ballroom followed the conclusion of the address.

ASHAE 1955 Semi-Annual Golf Tournament

Player	Net Score	Player	Net Score	Player	Net Score
J. F. Park	103	J. H. Rhoads	78	G. D. Maves	83
A. B. Lang	79	R. C. Chewning	88	E. F. Dill	80
W. O. Stewart	80	J. E. Schechter	70	R. C. Cushing	84
R. M. Hennessy	74	C. W. Johnson	79	L. F. Miller	85
R. R. Taylor	82	R. W. Nelson	84	E. V. Gritton	84
H. R. Bissell, Jr.	83	Arthur Nutting	85	Norman Brown	No card
F. W. Brundage	97	J. W. May	79	Clyde Reid	No card
James Gayner	80	H. J. Noles	95	J. H. Ward	80
J. McNeilly	91	R. H. Kremer	87	J. C. Beck, Jr.	100
Albert West	78	J. W. Cooper	78	E. O. Thomas	87
J. E. Wilson	77	G. W. F. Myers	77	W. A. Barron	81
E. C. Sanford	82	A. G. Hillen	88	P. R. Omohundro	88
J. F. Deane	78	Bruce L. Evans	75	W. H. Buck	80
V. C. Kneese	88	E. T. Clucas	82	C. J. Curtin	No card
W. L. Kell	80	C. D. Williams	79	M. F. Blankin	74
D. S. Sterner	90	R. R. Reece	91		
W. D. Maxwell	87	J. E. Murray	104		

EVAPORATIVE COOLING — A Symposium

Wm. T. Smith, *Chairman*

(Chief, Refrigeration & Air Conditioning Section, Headquarters, U.S. Air Force, Washington, D.C.)

Historical, by R. E. Phillips, Jr.	Vice President, Ralph E. Phillips, Inc., Los Angeles, Calif.
Air Cooling by Evaporation, by S. F. Duncan	Director of Research, Farr Co., Los Angeles, Calif.
Evaporation from Surfaces, by R. J. Petersen	Chief Engineer, Utility Appliance Corp., Los Angeles, Calif.
Weather Data Limitations, by Stuart Giles	Director, Heat and Sanitation Division, U.S. Naval Civil Engineering Laboratory, Port Hueneme, Calif.
Geographical Limitations, by Robert Ash	Assistant to the President, International Metal Products Co., Phoenix, Ariz.
System Design, by Richard Hukill	Supervisory Mechanical Engineer, U.S. Naval Civil Engineering Laboratory, Port Hueneme, Calif.
Indirect Systems, by D. T. Robbins	Chief Design Engineer, Holmes & Narver, Inc., Los Angeles, Calif.
Water Treatment, by R. M. Westcott	Partner, Holladay & Westcott, Los Angeles, Calif.

Historical Background

Evaporative water cooling was well known to ancient peoples. Frescoes dating from about 2500 B.C. show slaves fanning porous jars of water to keep them cool. In India evaporation was used to make ice. Shallow beds dug in the earth were filled with 1 ft of straw upon which shallow earthen pans were placed. On still, frosty nights even when the temperature fell no lower than 43 F or 11 deg above freezing, ice would be formed, sometimes 1½-in. thick. Evaporation plus radiation into the night sky provided the refrigeration. This method is reported to be in use in modern Iran also.

In Iran, homes are frequently semi-underground to escape solar heat and in some there is a pool of running water above which a ventilation tower opens. The tower catches the breeze and diverts it across the water pool and into the subterranean room. An ancient Persian practice was to cover tents with felt which was kept wet — a practice used by American Indians as well.

People in India developed the *Coco Tatti*. Doors are replaced in summer by Tattis or frameworks similar to screen doors, covered with dry grass, and kept watered by hand. Many are periodically soaked by a balanced trough at the top. Water trickles into this from a supply pipe until the trough is overbalanced and dumps its load on the pad. Gravity then rights it for the next cycle.

Another Indian evaporative air cooler is the *Thermantidote*. Here a door is replaced by a wheel-like framework covered with grass which is revolved and kept moist by laborers.

The cooling effect of falling water has also been used. It is reported that Peter the Great in one of his Leningrad gardens had a tree piped so that a curtain of water fell from its outermost branches, and surrounded, but did not wet, benches near the trunk.

Leonardo DaVinci constructed a mechanical air cooler consisting of a long water-wheel through which air was drawn and cooled by the rise and fall of water trapped within its chambers as they revolved. Gravity-operated valves discharged the air out of the hollow axle. Many other primitive cooling devices have appeared from time to time.

American evaporative cooling developed chiefly in Arizona and Southern California during the late 1920's and early 1930's. Homemade devices were common at first. Formal manufacture began about 1936 or 1937. As time passed the various methods developed and can be listed as: (*a*) the common desert cooler, (*b*) the air washer cooler, (*c*) the unit humidifier cooling system, (*d*) the exhaust type window pad cooler, (*e*) the rotating pad cooler, (*f*) the portable desert cooler, and (*g*) the indirect evaporative cooling systems. Brief mention is made here of some of the chief features of (*a*) to (*f*), while the indirect systems are discussed later. Use of the indirect systems is relatively recent.

The common desert cooler has a sheet metal pan as a base. Above this is a fan; in small units usually a propeller type, and in larger units a centrifugal type. The fan blows horizontally and is surrounded on 3 sides by saturation pads kept in place by louvered sheet metal, hardware cloth or expanded metal lath. The saturation pads are moistened by various devices. Excess water drains into a pan and is wasted or recirculated.

The air-washer cooler has been long used with central ventilating and heating systems primarily to clean and humidify the air for winter heating purposes. Its use for summer cooling is a later development.

The unit humidifier cooling system is used in many textile plants, where high humidity is desirable. Units are scattered throughout the plant, usually mounted overhead, and incorporate a means for discharging fine globules of water into the air. Air currents disperse and evaporate these globules.

The exhaust type window pad cooler reduces heat flow into buildings as well as removing some of the heat already in. This cooler is composed of separate flat saturated pads of sufficient size to cover

the windows, and the building is equipped with a large central attic exhaust fan. In the attic the exhaust air reduces the temperature and removes part of the heat, reducing the load.

Rotating pad coolers are relatively new. They use vertical flat wheel-like pads of crimped copper screen wire which revolve about an axis normal to their planes. The

1 - DESIGN OUTDOOR DRY BULB-(°F)	100
2 - DESIGN OUTDOOR WET BULB-(°F)	68
3 - COLD WATER TEMP. #2 + (5 to 7F)	75
4 - AIR TEMP. (DB) LEAVING COILS-(°F) #3 x (5 to 8F)	83
5 - WB TEMP. AIR LEAVING COILS-(°F) (FROM PSYCHROMETRIC CHART AT INTERSECTION OF DB TEMP. (#4) AND WATER VAPOR CONTENT OF AIR AT OUTDOOR DESIGN CONDITIONS)	62.3
6 - WB DEPRESSION, AIR LEAVING COILS (#4—#5)	20.7
7 - DB TEMP. AIR OUT OF EVAP. COOLER #4—(0.80 x #6)	66.4
8 - DESIGN INDOOR TEMP. DB-(°F) (#1—20F) = MIXING TEMP.	80
9 - TEMP. RISE OF COOLING AIR-(°F) (#8—#7)	13.6
10 - CU. FT. PER LB., DRY AIR AT COOLER DISCHARGE (FROM PSYCHROMETRIC CHART)	13.5
11 - TOTAL CFM REQUIRED. $\frac{\text{TOTAL HEAT LOAD}}{60 \times 0.24 \times \#9} = \frac{Q = 100{,}000}{\#10} = \frac{Q \times \#10}{14.4 \times \#9}$	6900
12 - ENTHALPY, AIR ENTERING COIL	32.4
13 - ENTHALPY, AIR LEAVING COIL (PSYCHROMETRIC CHART AT CONDITION #5, #2 FOR #12 AND CONDITION #4, #5 FOR #13) BTU/LB DRY AIR	28.2
14 - ENTHALPY CHANGE IN COILS (#12—#13)	4.2
15 - TOTAL HEAT TRANSFER IN COILS (#14 x #11/#10) IN BTU/MIN	2145
16 - TEMP. RISE IN COOLING WATER-(°F) (4 to 10F)	8
17 - WATER REQUIRED, GPM = #15/(#16 x 8.33)	32.2
18 - COIL SELECTION: FOLLOW COIL MANUFACTURERS RECOMMENDATIONS BUT USE AT LEAST A 6 ROW COIL.	

Fig. 1—Example of design sheet for use with evaporative cooling

lower one-third of the pads revolve in tanks of water and are thus thoroughly saturated.

The portable desert cooler is essentially a desert cooler of small size usually with a fan and an abnormally deep base. No water connections are provided and the owner fills the base reservoir periodically with a pitcher or other container. The unit is placed within a room preferably before an open window.

Air Cooling by Evaporation

The process of cooling air by evaporation of water is adiabatic since the construction of the cooler is such that no appreciable amount of heat is transferred to or from the surroundings. Being adiabatic, the process follows a constant enthalpy line on the psychrometric chart, but there is no serious error involved in charting it along a constant wet-bulb line.

A term used in connection with the performance of evaporative coolers is *humidification efficiency*, defined as the decrease in dry-bulb temperature during evaporative cooling, divided by the wet-bulb depression of the entering air. In operation, humidification efficiency can vary from between 20 or 30 percent to over 90 percent depending on the type of evaporative cooling device and the condition of the equipment. A reasonable value ranges from 70 to 80 percent.

To illustrate some features of the design of an evaporative cooling system, two systems will be considered here. The first is the straight evaporative cooling system. The second is a two-stage system using a cold water coil ahead of the evaporative cooler, the cold water being obtained from a cooling tower.

For both systems the outdoor conditions will be assumed at 100 F db and 68 F wb; evaporative cooler has humidifying efficiency of 80 percent; design indoor temperature at 80 F; and cooling load, 100,000 Btu per hr.

The cooling load is calculated by the usual methods but latent heat is not considered since the evaporatively cooled space uses 100 percent outside air and no moisture is condensed.

For straight evaporative cooling and the conditions assumed, the outdoor wet-bulb depression is 100 − 68 = 32 F. The air will be cooled 80 percent of this value so the air leaving the cooler will be at 74.4 F (100 − 0.80 × 32 = 74.4). The cooled air, as it absorbs the load, follows a line of constant humidity ratio from 74.4 F to 80 F for a rise of 5.6 deg. By following the cooling process from 100 F db and 68 F wb along the constant enthalpy line to 74.4 F db, the specific volume of the air leaving the cooler is about 13.75 cu ft per lb of dry air, and using the specific heat of air as 0.24, the air requirement is 17,000 cfm at 29.92 in. Hg barometer.

The second case is the two-stage system having cold water coils ahead of the evaporative cooler. Considering that cooling towers customarily deliver water at a temperature within 5 to 7 deg of wet bulb and a finned coil 6 to 8 rows deep can provide air within 7 or 8 deg of cold water temperature, the temperature of the air leaving the coil can safely be assumed at 15 deg above wet bulb, or 83 F. Cooling in the coil is at constant humidity ratio and the chart shows that the air leaving the coil is at about 62.5 F. From this point on, the computation of air condition is the same as for the first example except that it starts at 83 F db and 62.5 F wb. The air requirement for the 100,000 Btu per hr cooling load is 6900 cfm, a much lower value than the 17,000 cfm required for straight evaporative cooling. These computations are summarized on design sheet shown in Fig. 1, which sheet also shows the method for computing the water flow rate required in the coil.

Though much evaporative cooling is in locations close enough to allow the use of charts drawn for a barometer of 29.92 in. Hg, some locations require the use of either a corrected chart or correction factors. The effect of an elevation of 4800 ft is to raise the cfm requirements at the cooler outlet to 20,000 and 8500, respectively.

The numerical values for the two examples are subject to change in the judgement or experience of the individual designer. The value of efficiency chosen is one met by several brand-name coolers and is one that can be called out with confidence. The temperature differences are reasonable and attainable.

Evaporation from Surfaces

Evaporation from surfaces can best be explained from the concept of *mass transfer*. When mass is exchanged between a solid or a liquid surface and a moving fluid, the transfer is considered to take place by convection. This transfer process is called *forced* convection if the fluid motion is forced, or *free* convection if the fluid motion is due to gravity.

The theory of mass transfer by convection is analogous to the theory of heat transfer by convection. Consider an example of heat transfer from a flat surface to a moving air stream. In this case, there is a film of hot air adjacent to the hot surface. Some of the air from this film is picked up and transported by the air stream. In the case of evaporation from

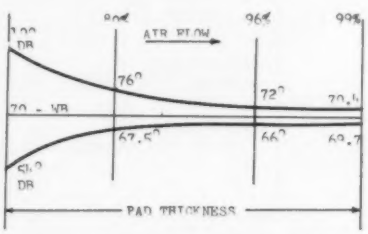


Fig. 2—Graphical representation of temperature changes as air flows through evaporative pad

the wetted surface the process is similar, there being a film of saturated air at the surface. Some of the saturated air is picked up by the moving air stream.

The rate of heat transfer is usually expressed as:

$$q = KV^{\frac{1}{3}}A\Delta t \quad \text{.....(1)}$$

where

q = rate of heat transfer, Btu per hr.

For evaporation from a similar wetted surface the formula for mass transfer is:

Mass transfer per unit time = $KV^{\frac{1}{3}}A$ (Vapor pressure difference) .....(2)

The two formulas are similar. Both heat transfer and mass transfer vary approximately as the 2/3 power of the air velocity. With mass transfer, the difference in vapor pressure is the driving force, whereas, in the case of heat transfer, it is temperature difference.

In most processes involving heat and mass transfer between water and air, both the water and air change temperature during the process. This is true for cooling towers, evaporative condensers, and also for those air washers in which the circulating water is either heated or cooled. In the ordinary evaporative cooler, however, the circulating water is not heated or cooled and consequently it assumes the wet-bulb temperature of the incoming air.

It is interesting to see what happens to the air as it flows through an evaporative medium, or pad. Assume the following inlet conditions: DB — 100 F; WB — 70 F; DP — 54 F.

Fig. 2 is a graphical representation of what takes place. As the warm air enters the pad, its temperature drops rapidly at first, but as it penetrates farther, the rate of cooling decreases. This is because the vapor pressure differential decreases as the air approaches saturation.

In the design of evaporative coolers, many manufacturers make the pads of a thickness to give a saturation efficiency of about 80 percent. Where aspen excelsior pads are used, it is common practice to use a pad face velocity of 230-300 fpm and a pad thickness of about 2 in.

When pad face velocities are increased over 300 fpm, it becomes difficult to maintain the desired 80 percent saturation efficiency. This can be explained by referring to Equation 2. Let us assume that a given pad would provide a saturation efficiency of 80 percent at a face velocity of 250 fpm. If the velocity were doubled, the air flow would double, but the cooling effect due to evaporation would increase as $2^{\frac{1}{3}}$ or 1.59 times. Therefore, the saturation efficiency at 500 fpm would be expected to be (1.59/2.00) × 80 percent = 64.7 percent.

If a cooler is to operate at higher pad velocities, it is necessary to increase pad thickness in order to maintain efficiency.

Higher pad velocity permits reducing the size of equipment, but at the cost of higher friction loss through the pads and consequent higher power cost for pumping air through the cooler.

Weather Data and Evaporative Cooling

I think that no one will argue against evaporative cooling when weather conditions are ideal. The big discussion results from attempts to develop rigid rules defining suitable climatic conditions for evaporative cooling installations. Many plans have been proposed. As an example, Rummel[1] proposed a system and, from this system, plotted the map shown in Fig. 3.

This map covers, in a general way, the areas most suitable for this type of cooling but parts of the country which are using evaporative cooling extensively are not included. This is probably not only because of a lack of suitable weather data but also because of the definition used to establish the hours of wet-bulb and dry-bulb temperature levels required for the use of evaporative coolers. Fig. 4 is a portion of a world map which has been suggested to the Bureau of Yards and Docks for use as a guide to determine which areas *may* be suitable for this type of cooling. This map was developed from a study made by *UNESCO* on desert and arid regions of the world and, although it was probably based on rainfall data, it appears to check in a general way with the map of Fig. 3.

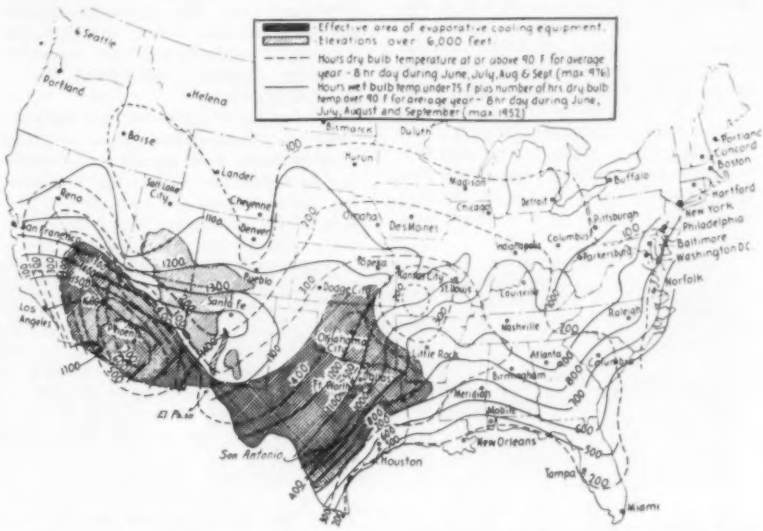


Fig. 3—Map showing U.S. localities where evaporative cooling is practical as determined by formula based on weather analysis

Fig. 4—U.S. portion of a world map suggested as useful in determining areas where evaporative cooling is practical based on UNESCO study of rainfall data

These maps also draw a sharp line which is really not the way to represent the solution. Fig. 5 is a map indicating the relative sales volume of evaporative coolers in the U. S. This represents an estimated annual volume of 500,000 to 600,000 units, and since the sales concentrations are not in agreement with the weather data analysis previously discussed, it is evident that something is amiss in the engineering approach. The approach must be too rigid. Obviously, some small home owners or business operators in borderline areas cannot afford, or at any rate do not use, refrigeration, even though it would give them much more comfort. They have found by experience that, in spite of what engineers tell them, evaporative cooling is a big help and they, therefore, buy thousands of evaporative coolers.

This phenomena may be analyzed by referring to the usual comfort chart. With an outdoor condition of 105 F db and 80 F wb, an evaporative cooler might reduce this to 85 F db and 80 F wb inside the building. Obviously, the outdoor climate is a very difficult working condition and the resultant indoor condition is not in the comfort range of the usual chart, even if a 200 ft air velocity were induced in the space. The fact still remains that people can and will work under these conditions, whereas, if no cooling were provided, no one would report for duty.

With these ideas in mind, let us examine a method of calculating from weather data

[1]Evaporative Cooling Map, by A. J. Rummel (*Heating, Piping & Air Conditioning*, January 1941, p. 44).

the suitability of a particular area for evaporative cooling. This method is based on a sliding scale of acceptability. As shown by Fig. 6, one is good, one is fair, and one is fringe. Here calculations are based on the number of hours that the temperature is above 90 F db and the number of hours above a variable wet bulb. As can be seen, the determining factor is the wet bulb which varies from 70, to 73, to 76. There is no convincing evidence that the particular constant assumed for this ratio is the right one, but it is felt that this is the proper approach. It is hoped these

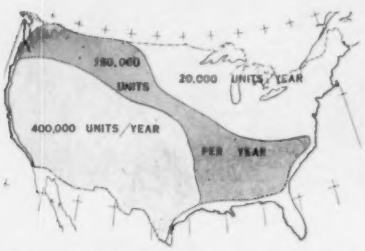


Fig. 5—Map showing sales distribution coolers in U.S. (1954 estimate)

equations can be field checked during the coming year.

Refrigeration air conditioning design practice is apparently a stumbling block to the engineer applying evaporative cooling for the first time to a building design. Empirical rules used for refrigeration work such as designing for a 15 to 20 deg split between supply air and room air temperatures cannot be used for evaporative cooling. It must be remembered that evaporative cooling uses four to six times the amount of outside air that is used with refrigerated cooling. Outside air supply at 70 F and above is not uncommon.

For this reason, the velocity effect from evaporative coolers must not be overlooked. It must be kept in mind that the human skin temperature averages 83 F. Often, to produce relief from the heat, air must be blown into the room at 80 F. In refrigeration air conditioning design 50 F to 60 F supply air temperatures are used; because of this, poor diffusion or high ambient velocity produces uncomfortable conditions. With evaporative cooling, supply air temperatures as high as 85 F db can provide relief from desert conditions. This is because sufficient air velocities are induced within the occupied space to materially increase the body heat losses.

Geographical Limitations

"One of the most important principles of air conditioning is manifested in the cooling produced by the evaporation of water. When air, partially saturated, comes in contact with water . . . . a certain amount of heat is absorbed from the air in the process of evaporation, effecting an appreciable lowering in the temperature of the air. . . . It is of interest to note that in addition to the cooling obtained from the evaporation of water, the effect of air movement reaches a maximum value at saturation and an enormous amount of cooling results from the combination of the two. . . . The process involves the use of simple and inexpensive equipment, and it is very likely that this most efficient method of artificial cooling will be extensively used in the future." The foregoing statement appeared in the ASHVE TRANSACTIONS of 1924.

Although this prediction has certainly come true, judging from production and sales figures of firms manufacturing evaporative coolers, the engineering profession has not recognized the suitability of this form of air conditioning except for a relatively insignificant section of the Southwest. A search of recently published handbooks and textbooks reveals an almost complete absence of information on evaporative cooling. THE GUIDE 1955 simply states, *In climates where, on the hottest days, the outdoor wet-bulb depression is relatively great, it may be possible to replace mechanical refrigeration, or other cooling sources, and use the evaporative cooling effect.*

Many engineers feel that evaporative cooling is satisfactory only for those areas where the prevailing summer wet-bulb temperature is sufficiently low to permit evaporative cooling to duplicate the conditions usually specified for air conditioning using refrigeration equipment: namely, 80 F db temperature, 50 percent RH and 25 fpm air velocity in the occupied space. These design conditions require a wet-bulb temperature under 70 F, a condition met nowhere in the United States except in the thinly populated mountain states and the inland valleys of the west coast.

Although this viewpoint is widely held by engineers, the public, not blessed with the expert knowledge that it will not work in other areas, has eagerly accepted evaporative cooling. As a consequence, coolers are now in common use in cities such as Atlanta, Tulsa, and Dallas; and they represent larger markets for coolers than, say, Salt Lake City with its 65 F wb temperature. It is interesting to note that even Phoenix, birthplace of evaporative cooling, has a wet bulb of 76 F, which presumably makes it unsuitable for this type of cooling.

There must be a reconciliation between the buying habits of the people and the standards established by the engineering profession, if the latter are to have meaning and are to serve the public. Much of the misunderstanding over evaporative cooling by engineers is due to applying refrigeration standards to this method of cooling. A re-evaluation of evaporative cooling should be made to adjust engineering standards to actual practice, so that the confusion and misunderstanding that exist will be dispelled and the engineer will, thereby, be provided with facts that he can use in applying evaporative cooling for any geographical location.

A great difficulty in discerning the true effectiveness of evaporative cooling lies in a lack of understanding of the comfort chart. First, it should be remembered that this chart represents optimum conditions and must, therefore, be used with care. To say that 98 percent of the people are comfortable at 71 F ET and that only 70 percent of the people are comfortable at 74 F ET does not necessarily mean that 28 percent of the people have become uncomfortable. Comfort does not suddenly diminish on each side of the optimum condition. There are at least three primary and perceptible variations in comfort, *viz*: comfortably cool, ideally comfortable and comfortably warm.

It must also be remembered that the comfort chart is the result of research work conducted by the Society in 1923 — over 30 years ago. The subjects were

GOOD RESULTS:

$$\frac{\text{HRS OVER 90F DB—HRS OVER 70F WB}}{\text{HOURS OVER 90F DB}} = 2/3$$

FAIR RESULTS:

$$\frac{\text{HRS OVER 90F DB—HRS OVER 73F WB}}{\text{HOURS OVER 90F DB}} = 2/3$$

FRINGE RESULTS:

$$\frac{\text{HRS OVER 90F DB—HRS OVER 76F WB}}{\text{HOURS OVER 90F DB}} = 2/3$$

IT IS GENERALLY CONSIDERED UNNECESSARY TO PROVIDE ANY COOLING UNLESS AT LEAST 150 HOURS PER YEAR ARE 93F DB OR HIGHER. THE ABOVE RESULTS ARE FOR PERSONNEL AND NOT NECESSARILY TRUE FOR PROCESSES OR EQUIPMENT.

Fig. 6—Suggested scale for determining from weather data the suitability of a particular locality for evaporative cooling

clothed in lightweight union cotton underwear, madras shirt with collar attached and three piece medium weight woolen suit. Wearing apparel has changed considerably since those days! In warm weather areas, sport shirt and slacks are the order of the day. Research work, conducted by the Society as early as 1937, indicated that comfort is realized at from 2 to 3 deg ET higher when no coat is worn. Furthermore, the tests were conducted in Pittsburgh, which has less than fifteen days of summer weather exceeding 90 F. In warm weather areas, people are acclimatized to a higher temperature. THE GUIDE 1955 states, *A spread of 3 degrees in the optimum effective temperature for summer cooling is ascribed to geographical location.*

These remarks indicate that there is a wide spread of effective temperatures that will produce comfort and that the really important consideration should be the upper limit of comfort, taking into account present day dressing habits and acclimatization. It has been observed that a comfort feeling is experienced about the same time that sensible perspiration or sweating disappears. Findings of the Society, as well as of the Bureau of Ships, Department of the Navy, and others, indicate that sensible perspiration or sweating takes place at effective temperatures higher than 78 F for people lightly clothed. In the light of these findings, a logical and reasonable yardstick of the suitability of evaporative cooling

would be its capacity to maintain conditions at 78 F effective temperature or lower.

In discussing the role of effective temperature as a criterion of comfort, it must be remembered that it is an index combining the effect of temperature, movement of air and humidity. With evaporative cooling air velocities of 100 to 200 fpm of moist air at room temperature are not unpleasant. The effect is more or less similar to that of a breeze in the open air. In the deep South there is even a demand for perceptible air motion. The increase in air movement permissible with evaporative cooling materially widens the geographical limits. For people lightly clothed, an increase in air movement from 25 fpm to 200 fpm will in itself reduce the effective temperature as much as 4 deg. Evaporative cooling systems, while depending almost entirely on the cooling effect produced by the evaporation of water in areas of low wet-bulb temperature, may rely on air motion for as much as 50 percent of their effectiveness in cities such as Atlanta, Tulsa, and Dallas.

These higher rates of air movement reduce the diffusion temperature or the difference between the room temperature and the temperature of the supply air to 1 or 2 deg, which has the effect of increasing relative humidity. Frequently, the relative humidity within the conditioned space exceeds 70 percent, which is commonly believed to be the maximum humidity allowable for comfort. Recent research indicates rather conclusively that relative humidity is of much less importance than has been supposed. Actually, the findings revealed that people interpret as humid any hot condition where they perspire freely. Such reactions have been recorded when the relative humidity was actually as low as 30 percent. No limitation need, therefore, be placed on relative humidity providing the air is moving freely and the conditions do not result in sweating which can be avoided with 78 F ET and lower.

The foregoing remarks about effective temperature, humidity and air movement show that evaporative cooling systems can be designed to produce comfort conditions under widely varying climatic conditions; and that this important form of air conditioning should not be overlooked by the engineer, or be considered suitable only for arid or desert climates characterized by a low wet-bulb temperature. With the exception of a few isolated spots, such as the Red Sea and Persian Gulf, there are no geographical limitations on evaporative cooling.

System Design

Design of evaporative cooling systems is not unlike that of refrigerated air conditioning systems. Both use the same basic components. Evaporative cooling equipment may consist of capillary air washers, rotary evaporators, drip or slinger-type evaporators or coolers. Any of these may be used to give year-round operation.

With evaporative cooling provision should be made for exhaust air discharge. Standard design criteria for air conditioning are used for system design. Provision for reducing the air flow for heating is usually accomplished by means of two-speed motors or vortex dampers.

The design and equipment used depend upon the type and upon the funds allotted which may make it necessary to sacrifice architectural appearance, and to use the least expensive equipment and the barest minimum of air distribution and quantity.

The least expensive installation frequently consists of a *drip-type* evaporative cooler installed on a roof or on a wall discharging into the space through a minimum length of duct with an inexpensive grille or plaque on the outlet (see Fig. 7). This installation, properly designed, provides adequate cooling, but if water conditions and maintenance are poor, the efficiency of the cooler falls off, and the evaporating media must be replaced frequently. Water carryover may occur and cause corrosion of the fan and other metal parts. Access for servicing should be provided for coolers installed on roofs or high walls.

The *slinger* cooler, differs from the drip-type in its method of water distribution. It has a slinger wheel in place of a perforated pipe or channel. The slinger cooler is so constructed that the evaporating section can be used as a separate unit, thus permitting one or more of the sections to be built up into a central system. Water conditions often make it necessary to replace the evaporating media as efficiency falls off. The corrosion problem is reduced by a moisture eliminator behind the evaporative media (see Fig. 8).

Central evaporative cooling systems often use capillary-cell-type air washer units. In these, carryover of moisture is usually not a problem if velocities are properly chosen. Water treatment is a major consideration. As in the other types, uncontrolled scaling blocks off air passage through the cells, reduces efficiency, and may require frequent replacement of the cells.

Still another type is the rotary cooler, available as a complete cooler with blower or with an evaporating section only. The evaporator is designed with a built-in intermittent water flush device which controls scaling. The rotary evaporator is readily adapted to central system design (see Fig. 4).

The design of the air distribution system is important to obtain good results. Because of the large air quantities handled, special care must be taken to reduce noise and also to prevent uneven air velocities in the rooms. By use of properly sized diffusers or grilles, both of these problems can be solved. Such distribution with uniform air velocities in the range of 50 to 150 fpm at the breathing level produce excellent results.

Fig. 7—Roof installation of drip type evaporative coolers

Fig. 8—Roof installation of slinger type evaporative coolers

Indirect Systems

The principal indirect systems can be grouped as follows: (1) Simple dry-surface; (2) Indirect-direct; (3) Multi-stage; (4) Regenerative dry-cooling; (5) Plate type heat exchanger; (6) Combination of evaporative cooling with refrigeration or heating.

To evaluate their effectiveness design conditions can be assumed and then applied to each system. These conditions are: outside 100 F db, with 65 F wb; evaporator cooling efficiency, 80 percent (regardless of cooling device used); 1500 cfm delivered to the room; 15 deg dry bulb rise in the room; sensible heat ratio, 0.95.

Consider first the *simple dry-surface* cooling system. The tower cools the water, circulated in the tower and through a dry coil, to within 4 deg of the wet-bulb temperature of the entering outside air; this water is then circulated through an extended fin, multi-row coil of counter-flow type which cools the air to within 4 deg of entering water temperature with nominal face velocity of 500 fpm and water velocity of approximately 3 fps. Water entering the dry coil is then 69 F (*i.e.* 65 F outside wet bulb plus 4 deg), and the outside air passing over this coil leaves at 4 deg above the water temperature (or 73 F db) and is blown into the room by the fan. On the basis of 15 deg rise, the room dry bulb is 88 F and, for a sensible

heat ratio of 0.95, the wet bulb is 61.2 F, equivalent to an effective temperature, on the ASHAE Chart, of 75.7 F.

The *indirect-direct* system is a modification of the simple dry surface system in which return air from the room is mixed with outside air in the ratio of 60 to 40 percent and this mixture is blown through an extended surface cooling coil which reduces both the dry-bulb and wet-bulb temperatures. This coil being of the multi-pass counter-flow type cools the air within a few degrees of the water temperature. The cooled air is now divided in the same proportions, 40 percent going into a spray chamber or air washer in which the water from the coils is sprayed and recooled by evaporation. The water is recirculated through the coils. Saturated air is exhausted to the atmosphere. The remaining portion of the cooled air is ducted to the room to be cooled. Another variation divides the mixed air directly from the fan as an uncooled mixture of outside and return air. It enters the washer warmer than with the other arrangement but reduces the cooling coil load so that the air delivered to the conditioned space is slightly cooler than with the first arrangement. With this system, under the conditions as outlined, the room dry bulb is 86 F, wet bulb 61.2 F, and effective temperature is 74.5 F.

The *multi-stage* cooling system may have several variations. One is the *cascade system* and consists of two or more spray chambers, one or more air-to-air heat exchangers and two or more fans. Theoretically, if enough stages are provided the air can be introduced into the conditioned space very close to the dew point temperature of the outside air. Practically, probably two stages of adiabatic heat exchangers and one stage of dry air-to-air heat exchanger is as far as it is economical to go. Outside air is passed through a spray chamber in which the water is recirculated and the air is saturated to 80 percent at a constant wet bulb. The air is then passed through a counter-flow air-to-air heat exchanger, preferably of the plate type, and exhausted. Outside air is passed through the heat exchanger and is cooled by giving up heat to the cooler, nearly saturated air. The saturated air leaves the spray chamber at 69 F db, as before. Outside air can be cooled in the heat exchanger to within a very few degrees of the temperature of the wet air. However, this requires large heat exchanger surfaces. Assuming an approach of 12 deg to the moist air temperature the amount of surface in the heat exchanger is not excessive and the air being cooled leaves this portion of the equipment at 81 F db and 58.3 F wb. The air is then blown through the second stage spray chamber where its moisture content is raised to 80 percent saturation, lowering the temperature to 62 F db with the wet-bulb temperature remaining constant. Under the same conditions, of 15 deg rise in the room and a sensible heat ratio of 0.95, the room temperature is 77 F db and 64 F wb giving an effective temperature of 75.1 F.

Another variation of the multi-stage indirect cooling system replaces the air-to-air heat exchanger with a water-to-air heat exchanger producing the same results in the conditioned space. A smaller heat exchanger accomplishes the same result due to the better transfer rate when one side of the surface is wet.

The *regenerative dry surface cooling system* bypasses the cooled air withdrawn from the conditioned space through the spray chamber in place of outside air. The spray water may be cooled to within approximately 4 deg of the room wet bulb rather than the wet-bulb temperature of the outside air. This system requires two fans, a spray chamber and an extended surface heat exchanger. Air is drawn from the room by a fan and is discharged through a spray chamber, cooling water which is circulated by a pump through an extended surface heat exchanger. Outside air is drawn over the coil by another fan and ducted into the room. With this system, room conditions of 83.5 F db and 60 F wb can be obtained under the same conditions assumed before. This produces an effective temperature of 73 F.

The *plate-type heat exchanger system* is a variation of (4) in which the cool return air from the conditioned space is passed through a spray chamber and ducted into a large plate type air-to-air heat-exchanger where, by conduction, it cools fresh outside air which is delivered into the conditioned space. Room conditions are comparable to the regenerative type previously discussed. The disadvantages are bulk and cost.

Another *plate-type system consists* of a vertical heat exchanger used as both cooling tower and cooling surface. Air and water spray are drawn downward in alternate thin passages and fresh air is drawn upward in the intervening ones. Thus the heat transfer is more nearly air-to-water and less surface is needed.

This system requires two fans: — one for the fresh air, cooled and delivered to the conditioned space; and one for the air saturated by the spray and discharged to the atmosphere or into an attic space where an additional beneficial effect is realized.

Various *combinations* of evaporative cooling with precooling, with refrigeration and with heating are possible and are discussed briefly.

Where well water is available at approximately the wet-bulb temperature of the outside air, good results may be obtained by precooling outside air with the well water and then passing this air through a spray chamber and blowing it into the conditioned space with a fan. Under the conditions used previously as a standard in this discussion, with well water available at 70 F the outside air may be precooled by well water in extended surface coils from 100 F db and 65 F wb to 77 F db and 56.3 F wb. Then in the spray chamber this air is saturated to 80 percent at a constant wet bulb. Therefore, the air leaves the spray chamber at 60 F db and 56.3 F wb. The room temperature is 75 F db and is 62.5 F wb. This is equivalent to an effective temperature of 70 F. It will be noted that these conditions can be produced by well water at 70 F under the assumed outside air conditions of 100 F db and 65 F wb. A cooling tower can supply water for precooling at the same 70 F.

Under some conditions, indirect evaporative cooling may be used effectively in conjunction with refrigeration. There are many other variations and systems combining evaporative cooling with dry surface cooling which have great potentialities, but which cannot be described in the limited time and space available.

Water Treatment

The objective of water treatment is to reduce overall maintenance, protect capital investment and provide a higher operating efficiency. Unless there is a substantial gain in these objectives through water treatment, it has little to justify it.

With minor exceptions, there appears to be little justification for water treatment applied to once-through drip-type evaporative coolers. Any cooler with a recirculating water system may be improved in life and operational efficiency by proper water treatment, intelligently applied.

It would be a fallacy to prescribe any specific water treatment program for universal application and expect any high percentage of success. In general, the three basic problems to which water treatment is directed are scale deposits, corrosion and algae growths.

Scale deposits clog the wetted surfaces and eventually restrict air flow. Depending on the type of wetted surface, these deposits may or may not be cleaned by severe acid treatment. If the pads are made of organic material (wood fibers), cleaning with acid may practically destroy them. If the surfaces are metal but are not highly resistant to corrosion, severe corrosion may follow the acid cleaning.

Scale deposits are the result of the reconcentration and deposition of the minerals normally present in the water supply which remain after evaporation of the water. Air-borne minerals, dust, dirt and leaves, along with spores of algae, are also trapped on the wetted surfaces.

The one sure method of reducing scale deposits is to establish a foolproof bleed to keep the concentration of solids in the recirculated water at a reasonable level.

Corrosion can be prevented by two methods only, (*a*) an adequate protective coating or (*b*) corrosion resistant metal construction. Water treatment will be effective only where there is an actual flow of treated water over the surface to be protected.

Algae growths can be controlled by proper chemical treatment, either to destroy the organic material or to kill the growths.

In every case where water treatment is to be used, it is necessary to carefully select the chemicals to be used, methods of feeding the chemicals, quantities required, toxic values if any, which may enter the cooled air stream, methods of bleeding or dumping to reduce concentrations and overall maintenance to be expected. Satis-

John R. Allen Memorial Library

The ASHAE Committee on Research gratefully acknowledges the following gift to the John R. Allen Memorial Library, which is maintained at the Society's Research Laboratory, 7218 Euclid Ave., Cleveland 3, Ohio.

American Foundations for Social Welfare, by Shelby M. Harrison and F. Emerson Andrews. Gift of John E. Haines.

The presentation of textbooks and pamphlets in the field of heating, ventilating and air conditioning and allied fields, by authors and others, will be welcomed by this library. Suitable book plates carry the name of the donor and date of the gift.

factory results cannot be expected if water treatment is applied on a hit and miss basis or without intelligent evaluation of the initial water quality, specific installation conditions, and maintenance available.

Chemical treatment in one form or another coupled with good maintenance procedures is still accepted as a proven standard method. No single chemical or compound will provide satisfactory results for all water treating problems. In general, the polyphosphates have provided the highest batting average for scale control in evaporative cooling or water cooling applications. The most desirable procedure is to use a chemical which can be fed to the makeup water on a continuous basis and to maintain a constant blow-down or bleed of the recirculated water. It is obvious that batch treatment and periodic draining does not meet this condition. Periodic draining by automatic dump valves, if done at reasonable intervals, before concentrations get too high, is just about as effective as continuous blow-down and possibly more foolproof.

In conclusion, water treatment can improve evaporative cooler performance if properly selected and applied with good maintenance.

Abstracts of Discussions

Those who took part in the discussions from the floor at the symposium session were: Leo Hungerford, Los Angeles; J. E. Marshall, Sacramento; David Resnick, Los Angeles; H. S. Dutcher, New York; Mr. Anderson, Corps of Engineers; Harry Buchberg, Los Angeles; W. A. Grant, Syracuse; P. B. Gordon, New York; John Everetts, Jr., Philadelphia; J. E. Murray, San Francisco.

Among the points brought out in the discussions were:

1. Operating control is accomplished readily with a room thermostat and a room humidistat.

2. The assumed evaporation efficiency of 80 percent is conservative and can be bettered in an air washer, for example.

3. Various Federal government agencies, notably the Air Force, Navy and Corps of Engineers, are interested in the subject, hope to improve design procedures, are working on design methods, have a large number of installations in operation, would like to have Society co-operation, would like to work out suitable specifications; and, in some cases at least, regard this form of cooling as the only one which can produce tolerable working conditions in many instances at a cost which can be afforded under present circumstances.

4. Use of a velocity of 200 fpm in an occupied space with small temperature differentials has justification from the standpoint of practical application.

5. Evaporative cooling should be regarded as relief cooling rather than comfort cooling, should be promoted and sold for that purpose, and it should be recognized that where money is available (and in localities of high wet bulb generally) comfort cooling by the use of refrigeration is desirable and widely used even where wet bulbs are low, as in Phoenix, Ariz.

6. That recent studies by the Society have re-evaluated the comfort data of 1923.

7. That 78 deg effective temperature is a point where relief from perspiration can be experienced and may be regarded as a relief means rather than as a comfort condition.

8. Present practice in evaporative cooling in regions where there is a high wet bulb is to use very large quantities of air and a small temperature change. Air changes may run as high as one every minute and one-half to two minutes and the rise in air temperature may be no greater than two or three degrees.

Society Represented at British Engineers Meeting

For the first time the Society was officially represented at a meeting of the *Institution of Heating and Ventilating Engineers*. President Haines appointed Dr. Robert S. Aires of R. S. Aires and Associates, New York, as the official representative at the summer meeting of the Institution held at Eastbourne, England. At the dinner on June 21, Dr. Aires in accordance with the usual custom proposed the following toast on behalf of the Society.

I bring you the greetings and best wishes of the AMERICAN SOCIETY OF HEATING AND AIR-CONDITIONING ENGINEERS. In view of the importance and vast strides made by air conditioning, our Society saw fit to replace ventilating in its name by air conditioning. Having seen the recent progress made in this field in western Europe, I believe that the air conditioning *era* will overtake you in the future almost as much as it has in many areas of the United States of America.

Our President, John E. Haines, is particularly happy to foster co-operation between the American Society and its sister societies in other countries. I am pleased to say that your own President Vernon C. Hardy, one of the most forward looking and progressive individuals I have ever met, also told me that he is glad to see overseas representation at an annual meeting started during his term of office. With such hard-working secretaries as your Mr. Swain and our Mr. Hutchinson I can see a very close co-operation between the two societies in the future.

The ASHAE is composed of about 10,000 members engaged in the profession, as well as researchers and educators. It was established in 1894. It is not very often that we can claim historical priority in the United States, but it shows that men of vision in more than one country have similar ideas at about the same time. Similarly our Research Laboratory, which was established in 1919, indicated our desire to advance through basic and fundamental research to achieve human comfort and health.

The aim of the Society is to conduct fundamental research, encourage publication of engineering data and development of standards, encourage high standards of technical and professional training, as well as to co-operate with others with similar objectives.

Our regular meetings are in January and June. We hope that any of your members who will be in the United States at that time could attend them, and you will indeed be welcome. Every two years a famous International Exposition is held under the auspices of our Society, and I may suggest that this could be a particularly interesting time to attend our meetings.

We are particularly proud that we are the only U. S. engineering society which operates a laboratory in addition to many research projects sponsored elsewhere. Forty percent of our dues are allocated to research, and every member, whether in the U. S. A. or elsewhere, benefits by the dissemination of this research. I might add that in the U. S. A. engineering societies accept with equal rights overseas members on the basis of their qualifications, rather than an examination.

Over 750,000 pounds have already been spent by us on research and our research budget at present is about 100,000 pounds.

Our TRANSACTIONS are published annually, and our society JOURNAL is published monthly. In addition, we have an annual GUIDE giving data from our Laboratory and other sources.

I propose a toast to your Institution and to Mr. Hardy, its President.

Canons of Ethics for Engineers*

Foreword

HONESTY, justice, and courtesy form a moral philosophy which, associated with mutual interest among men, constitutes the foundation of ethics. The engineer should recognize such a standard, not in passive observance, but as a set of dynamic principles guiding his conduct and way of life. It is his duty to practice his profession according to these Canons of Ethics.

As the keystone of professional conduct is integrity, the engineer will discharge his duties with fidelity to the public, his employers, and clients, and with fairness and impartiality to all. It is his duty to interest himself in public welfare, and to be ready to apply his special knowledge for the benefit of mankind. He should uphold the honor and dignity of his profession and also avoid association with any enterprise of questionable character. In his dealings with fellow engineers he should be fair and tolerant.

Professional Life

1. The engineer will co-operate in extending the effectiveness of the engineering profession by interchanging information and experience with other engineers and students and by contributing to the work of engineering societies, schools, and the scientific and engineering press.

2. He will not advertise his work or merit in a self-laudatory manner, and he will avoid all conduct or practice likely to discredit or do injury to the dignity and honor of his profession.

Relations With the Public

3. The engineer will endeavor to extend public knowledge of engineering, and will discourage the spreading of untrue, unfair, and exaggerated statements regarding engineering.

4. He will have due regard for the safety of life and health of the public and employees who may be affected by the work for which he is responsible.

5. He will express an opinion only when it is founded on adequate knowledge and honest conviction while he is serving as a witness before a court, commission, or other tribunal.

6. He will not issue ex parte statements, criticisms, or arguments on matters connected with public policy which are inspired or paid for by private interests, unless he indicates on whose behalf he is making the statement.

7. He will refrain from expressing publicly an opinion on an engineering subject unless he is informed as to the facts relating thereto.

Relations With Clients and Employers

8. The engineer will act in professional matters for each client or employer as a faithful agent or trustee.

9. He will act with fairness and justice between his client or employer and the contractor when dealing with contracts.

10. He will make his status clear to his client or employer before undertaking an engagement if he may be called upon to decide on the use of inventions, apparatus, or any other thing in which he may have a financial interest.

11. He will guard against conditions that are dangerous or threatening to life, limb, or property on work for which he is responsible, or if he is not responsible, will promptly call such conditions to the attention of those who are responsible.

12. He will present clearly the consequences to be expected from deviations proposed if his engineering judgment is overruled by nontechnical authority in cases where he is responsible for the technical adequacy of engineering work.

13. He will engage, or advise his client or employer to engage, and he will cooperate with, other experts and specialists whenever the client's or employer's interests are best served by such service.

14. He will disclose no information concerning the business affairs or technical processes of clients or employers without their consent.

15. He will not accept compensation, financial or otherwise, from more than one interested party for the same service, or for services pertaining to the same work, without the consent of all interested parties.

16. He will not accept commissions or allowances, directly or indirectly, from contractors or other parties dealing with his client or employer in connection with work for which he is responsible.

17. He will not be financially interested in the bids as or of a contractor on competitive work for which he is employed as an engineer unless he has the consent of his client or employer.

18. He will promptly disclose to his client or employer any interest in a business which may compete with or affect the business of his client or employer. He will not allow an interest in any business to affect his decision regarding engineering work for which he is employed, or which he may be called upon to perform.

Relations With Engineer

19. The engineer will endeavor to protect the engineering profession collectively and individually from misrepresentation and misunderstanding.

20. He will take care that credit for engineering work is given to those to whom credit is properly due.

21. He will uphold the principle of appropriate and adequate compensation for those engaged in engineering work, including those in subordinate capacities, as being in the public interest and maintaining the standards of the profession.

22. He will endeavor to provide opportunity for the professional development and advancement of engineers in his employ.

23. He will not directly or indirectly injure the professional reputation, prospects, or practice of another engineer. However, if he considers that an engineer is guilty of unethical, illegal, or unfair practice, he will present the information to the proper authority for action.

24. He will exercise due restraint in criticizing another engineer's work in public, recognizing the fact that the engineering societies and the engineering press provide the proper forum for technical discussions and criticism.

25. He will not try to supplant another engineer in a particular employment after becoming aware that definite steps have been taken toward the other's employment.

26. He will not compete with another engineer on the basis of charges for work by underbidding, through reducing his normal fees after having been informed of the charges named by the other.

27. He will not use the advantages of a salaried position to compete unfairly with another engineer.

28. He will not become associated in responsibility for work with engineers who do not conform to ethical practices.

*Prepared by the *Engineers Council for Professional Development* and subscribed to by the AMERICAN SOCIETY OF HEATING AND AIR-CONDITIONING ENGINEERS, and published for the information of the members of the Society.

THE PRESIDENT'S PAGE

Ethics for Engineers

A few years ago the Engineer's Council for Professional Development prepared and published the "Canons of Ethics for Engineers" which are reproduced on the opposite page for the information of our members. The Council has voted to subscribe to these canons prepared by ECPD, but as a Society we cannot adopt or enforce a code of ethics. I strongly recommend that every member of the Society read these canons carefully and remove the page for future reference or perhaps for framing in the office.

The opening paragraph of the Foreword expresses the general fundamentals of engineering ethics in a very descriptive manner:

> Honesty, justice, and courtesy form a moral philosophy which, associated with mutual interest among men, constitutes the foundation of ethics. The engineer should recognize such a standard, not in passive observance, but as a set of dynamic principles guiding his conduct and way of life.

Ethics is a subject closely related to the ability to get along well with people. And, getting along well with people is of prime importance. No engineer can do his best work or be successful without the concurrence of other people.

To understand people requires that we realize first of all that we are all different, we act and react differently, and sometimes we do not understand why.

It has been said that most people react from 90 percent emotion and 10 percent reason. The lawyer may sometimes find it desirable to create situations which are circumstantial rather than fact. The merchant often depends upon human emotions to make sales. Even the physician must deal with emotions if he is to be successful.

But, the engineer must deal with facts and it often becomes difficult for an engineer to realize that people have emotions and that emotions may be the basis for people's opinions and decisions.

I was impressed by a recent publication of the Royal Bank of Canada which said this:

> There are many virtues, but four are of leading importance to the person seeking to live and work successfully with people. They are consistency, sincerity, courtesy, and friendliness.

You will notice that courtesy is also included in the Foreword of the Canons of Ethics for Engineers, and this bank publication continues:

> Courtesy is the easiest quality to lift one above the crowd. Very often it is lacking in any masterful quality, but in it abides a wistful appeal that wins friends.

These are things to think about because if our Society is to continue to advance the arts and sciences of our profession, our accomplishments must be accepted and be made known to the general public.

While these canons cover many principles, they by no means cover all ethical problems.

As a small example of such a problem, there is the matter of the use of the Society name. Is it ethical and proper to use the Society name on personal letterheads and business cards? There appears to be a general belief among our members that such use is improper. Where this belief exists it is incorrect because it is very desirable that we use the name of the Society whenever and wherever appropriate.

It should be kept in mind that membership in the Society is a personal matter and the name or initials of the Society should be used with the name of the member preceded by his membership grade. The membership grade may also be indicated by initials in the following manner:

> Honorary Member (Hon. M. ASHAE); Member (M. ASHAE); Associate Member (A.M. ASHAE); Junior Member (J.M. ASHAE); Affiliate (Aff. ASHAE).

Since companies, partnerships, or corporations may not be members of the Society, it is improper to use the name of the Society in connection with any name except the name of the individual who is a member.

Even in small matters, we should all follow ethical principles and larger matters will fit into the pattern.

J. E. Harris

President

American Society of Heating and Air-Conditioning Engineers

Honored by Life Membership

Charles A. Fuller, New York, N. Y. — Although retired in 1950, C. A. Fuller remains as consultant to Slocum and Fuller, New York, N. Y. He had acted as a consulting mechanical engineer since 1917. In that year, he was a member of the Society's Council.

Mr. Fuller was born in Otter Lake, Mich., on October 3, 1880. He attended the University of Michigan, receiving his B.S. in mechanical engineering in 1904. His first positions were in engineering drafting with Murphy Iron Works, and Great Lakes Engineering Works, both of Detroit, Mich. For two years following, he was an instructor in mechanical engineering at the University of Pennsylvania. After several years with Clark, MacMullen & Riley, New York, N. Y., Mr. Fuller went into private practice as a consulting mechanical engineer, both with his own office and in association as Timmis and Fuller; Griggs and Myers; Myers, Fuller and Addington; and for many years as Slocum and Fuller.

C. A. Fuller

Two books written by Mr. Fuller are entitled *Designing Heating and Ventilating Systems* and *Air Conditioning*. He is a licensed engineer in New York and New Jersey.

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William Edward Gray, Frederick, Md. — W. E. Gray, now a mechanical engineer at Camp Detrick, Md., has made a specialization of study in dehumidification.

Born in Willimantic, Conn., on September 4, 1889, Mr. Gray began his work in the plumbing and heating field as an apprentice to H. H. Lyman in his home town. After nine years of study in the field and a period with the Mexican Border Service during World War I, Mr. Gray became associated with the newly formed Carrier Engineering Corp. (now the Carrier Corp.) in New York City. He had the opportunity to work with such men as A. C. Buensod, A. E. Stacey, Jr. and L. L. Lewis. During his three years with Carrier and the following year with the American Blower Co., Detroit, Mich., he acted as erecting superintendent for air-conditioning equipment.

W. E. Gray

Some years later, Mr. Gray took considerable interest in the study of dehydration. He joined the National Dry Kiln Co., Indianapolis, Ind., where he gained knowledge of the science of lumber and veneer drying. While working with the Standard Dry Kiln Co., also of Indianapolis, he designed a system of humidification for lumber drying. Then, he invented a dry kiln and a spring car stop during his employ by Moore Dry Kiln Co., Jacksonville, Fla.

Entering the field of temperature and humidity control, Mr. Gray was appointed by The Powers Regulator Co., Chicago, Ill., as district manager over North Carolina, South Carolina, Virginia and Tennessee. In 1938, when Mr. Gray's two sons, Hamilton and Emerson, started Gray Engineering Co., Inc., High Point, N. C., their father covered consultation in the field of drying.

During World War II, Mr. Gray served as chief engineer of dehydration research at Beltsvile Research Center. He is now with Ralph M. Parsons Co. as senior mechanical engineer, U. S. Army Chemical Corps, Camp Detrick, Frederick, Md.

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H. Lee Moore, Pittsburgh, Pa. — A Member of the Society since 1919, H. Lee Moore had been affiliated with a student group of the Society at the University of Kentucky. He was a member of the Council of the Society from 1927-28, and served the Pittsburgh Chapter as their vice president in 1926, president in 1929, and a member of the board of governors from 1930-32.

H. L. Moore

Georgetown, Ky., was the place of Mr. Moore's birth on November 4, 1889. He received a B.M.E. from Kentucky State University in 1911. A couple of weeks after graduation, he started to work for the Buffalo Forge Co. in Buffalo, spending several months in the enginering department and then several months in the construction department, since the custom at that time was to install your own equipment. Mr. Moore has been connected with Buffalo Forge Co. ever since graduation, and since 1913 has been in charge of the Pittsburgh office of Buffalo Forge Co., handling the engineering and sales work for the Pittsburgh district.

Noise Problems

By H. A. Lockhart*, Morton Grove, Ill.

NOBODY likes noisy equipment. The general public may tolerate it as a necessary evil — for a while. But as modern living introduces more and more equipment, the public increasingly demands that this noise be eliminated or controlled.

Heating and air-conditioning engineers and contractors are very much involved in the noise control problem, and are earnestly seeking useful and reliable information on the subject. They are installing a steadily increasing amount of mechanical equipment, such as fans, compressors, and pumps, and each is a potential source of noise. The current use of higher air velocities in ducts makes acoustical treatment an absolute necessity in many systems.

Noise problems are not confined to installations of any particular size or type. Noise from a small residential heating system, or from a unit heater in a small commercial installation can be just as annoying as though it were coming from a large central air-conditioning system. No matter how well a system may heat or cool the space, the owner will never be satisfied if it is noisy.

Since noise in air-conditioning is so important, data are urgently needed to permit the engineer and contractor to design and install systems which will meet the acoustical requirements of each individual job. Such data are almost completely lacking, or if available, are in a form not readily applicable to the problems of the industry. At the present time there is not even a universally

accepted method of rating the noise level of equipment.

Information Needed

To design an air-conditioning system which will be acoustically satisfactory, the engineer should know the noise level of each piece of equipment used, the acoustical properties and requirements of the space to be conditioned, and the attenuation or contribution of each part of the system between the equipment and the space. Some of the specific information or basic data needed are as follows:

1. Further development of instrumentation and techniques for sound measurement.
2. One or more satisfactory and acceptable methods of determining and expressing the sound rating of equipment, both in the laboratory and in the field.
3. Sound attenuation in straight ducts, and in various types of duct fittings.
4. The effect of acoustical duct linings on sound attenuation for various duct sizes and at various frequencies.
5. Regeneration of noise by turbulence as at duct fittings, grilles and dampers.
6. The acoustic absorption properties of typical rooms or spaces in which air-conditioning equipment or outlets are located.

Proposed Research

The ASHAE Technical Advisory Committee on Sound and Vibration Control expects to initiate a comprehensive research program soon to develop the acoustical data needed by the air-conditioning engineer. As a first step, a project has been outlined for the study of methods of measuring and expressing the noise level of various types of equipment. Specifically, a study will be made of appropriate methods of applying the sound power concept of measurement to the determination of fan noise. This method of measurement will be compared with at least three other methods of sound measurement, so that the relative advantages and disadvantages of each can be determined.

An outline is also being prepared for the study of sound attentuation in ducts and duct fittings, and it is hoped that this second phase of the problem can be activated soon. This would also include research on the effect of various types of acoustical linings for ducts.

It is expected that the study of methods for determining equipment noise levels will be done at the Society Laboratory in Cleveland, Ohio. Suitable space is available and staff can be transferred to this project as needed. The study of sound attenuation in ducts may be done either at the Society Laboratory, or by a cooperating institution.

The proposed research on sound will be done under the advisory guidance of the TAC on Sound and Vibration Control, the membership of which is as follows: H. A. Lockhart, chairman; A. F. Hubbard, vice chairman; C. M. Ashley, A. E. DeSomma, Sidney Gordon, W. F. Hagen, H. C. Hardy, E. M. Herrmann, C. R. Hiers, F. B. Holgate, G. C. Kerr, R. D. Madison, T. A. Walters.

*Chairman, Technical Advisory Committee on Sound and Vibration Control.

Summary of

• *ARIZONA*: Members present at the May meeting were asked by the presiding officer, Pres. W. A. Biddle, to act as representatives at the Society's 1955 Semi-Annual Meeting in San Francisco, if they planned to attend. J. B. Hoaglund, program chairman, then introduced the guest speaker, D. D. Wile, chief engineer, Refrigeration Engineering, Inc., Los Angeles, Calif.

Mr. Wile spoke on the *Performance of Chilled Water Coils*. He also presented a new method of selection of coils which had been presented by him at a recent *ASRE* meeting. Attendance 49. Attendance ratio 0.20.

• *CENTRAL OHIO*: The following officers were elected to serve the Central Ohio Chapter during 1955: *President* — R. A. Wilson; *Vice President* — W. A. Schoonover; *Secretary* — T. R. Walker; *Treasurer* — R. C. Liebert; *Board of Governors* — J. A. Guy, A. F. McGovern and R. L. Keener.

A very interesting talk on *High Pressure Hot Water Heat* was given by B. L. Breitman, American Hydrotherm Corp., New York, N. Y. Pres. J. A. Guy presided at the May meeting. Attendance 39. Attendance ratio 0.30.

• *CINCINNATI*: Officers to serve for 1955-1956 elected at the May meeting of the chapter are: *President* — A. H. Gerdsen; *Vice President* — R. G. Anderson; *Secretary* — T. D. Reiley; *Treasurer* — C. P. Krantz; *Board of Governors* — E. A. Sobolewski and F. W. Wilson.

The presiding officer, Pres. F. W. Wilson, relinquished the meeting to the new president, who then presented the Past President's Pin to Mr. Wilson. A rising ovation was given to the retiring president in appreciation of his services in the past year. Attendance 63.

• *DELTA CHAPTER*: Reports on the past year's activities were given by officers to Pres. C. V. Bankston, presiding at the May meeting. Officers elected to serve the chapter in the coming year are: *President* — W. B. Martin, Jr.; *Vice President* — H. N. Stall; *Secretary* — R. K. Goode; *Treasurer* — L. R. Maxwell; *Board of Governors* — J. T. Knight, Jr. and J. E. Leininger.

The retiring president presented the officers to the meeting which he then turned over to the new president. President Martin made a short speech of thanks as did the other newly elected officers, and a motion made by Walter Cooke to give them a round of applause and a rising vote of thanks was carried out with enthusiasm. President Martin then presented Mr. Bankston with a fountain pen and pencil set engraved with his name as President of Delta Chapter, 1954-55, as a token of appreciation from members. Attendance 43. Attendance ratio 0.29.

• *GOLDEN GATE*: Albert Hanson, Drayer-Hanson, Div. United States Radiator Co., Los Angeles, Calif., gave an interesting talk on the *Fundamentals of Design of Air Conditioning Coils* at the May meeting.

Prior to Mr. Hanson's talk, the presiding officer, Pres. Eric Roberts accepted reports from the nominating committee and other chapter committees. Attendance 80.

• *ILLINOIS*: ASHAE President, John E. Haines, Minneapolis, Minn., spoke at the May meeting to which past presidents of the chapter were also invited, on *The Challenger for Future Growth Held by the Industry*. President Haines' four main points were: Believe in the U.S.A.; Let's Be Optimistic; Invent New Ways of Doing Things; and Let's Believe in Our Society. Prior to President Haines' talk, M. J. Bamond presented a Life Membership Certificate to A. P. Brown.

Election results of chapter officers for 1955-56 were announced as follows: *President* — G. G. Freyder; *Vice President* — H. G. Gragg; *Secretary* — Herbert Kreisman; *Treasurer* — H. E. Anderson; *Board of Governors* — W. G. Pennington, J. C. Scott and C. M. Vreuls. After the incoming president received the gavel from G. V. Zintel, he presented Mr. Zintel with a Past President's Pin as his first official act.

The entertainment of the evening was provided by Martin McGowan, a big game hunter, who lectured on his six weeks safari to Africa, which he illustrated with a film. Attendance 101.

• *INDIANA*: The annual meeting of the Indiana chapter was held in May, and the following officers were elected: *President* — J. W. Jackson; *Vice President* — A. O. Roche, Jr.; *Secretary* — G. W. Vogel; *Treasurer* — W. W. Grear; *Board of Governors* — W. F. Currise, J. M. Teskoski and P. O. Patterson. President Jackson immediately assumed office and introduced R. C. Blackman, who presented the first Past President's Pin ever to be given in this chapter, to the retiring president, P. O. Patterson.

Prior to the election, a report from the Board of Governors was given, including the recommended Student Award to be made by the chapter to the outstanding member of the Purdue Student Chapter.

To conclude the meeting, a paper was presented by F. E. Ince, engineer, Marlo Coil Co., St. Louis, Mo., on *Testing and Rating of Forced Air Circulation Type Coil*. Mr. Ince, who was introduced by Mr. Teskoski, program chairman, illustrated his presentation with slides showing the test set-ups and methods used to rate coils. Attendance 35.

• *INLAND EMPIRE*: After the May meeting had been addressed by B. W. Farnes, member of council, Portland, Ore.,

B. W. Farnes

who reviewed the history and forecast the future of the chapter, officers for 1955-56 were announced as follows: *President* — F. W. Jenkinson; *Vice President* — Max Tonn; *Secretary* — J. A. Doyle; *Treasurer* — R. D. Nevers; *Board of Governors* — H. A. Bickel, R. B. Campbell and J. R. Morris.

President Jenkinson then presented Past Pres. H. A. Bickel with a set of Book Ends bearing the Society seal as a gift from chapter members.

Mr. Ross, The Fish Co., was introduced by G. C. Murray and gave a timely talk on *The Advent of Gas to Spokane*, its problems and advantages. A question period followed. Attendance 39.

• *IOWA*: A letter from ASHAE Past Pres. L. N. Hunter was read at the May meeting at which Pres. W. E. Nanes presided. Mr. Hunter gave recognition to W. A. Schworm for his contribution toward the preparation of the HEATING, VENTILATING AND AIR CONDITIONING GUIDE 1955, and his thanks were seconded by the chapter members.

John W. James

Officers elected at the meeting are: *President* — G. J. Kraai; *Vice President* — D. E. Schroeder; *Secretary-Treasurer* — W. A. Schworm; *Board of Governors* — W. E. Nanes, C. A. Wheeler and L. E. Gnade.

*Note: The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

Chapter Meetings*

Journal Section

John W. James, Chicago, ASHAE First Vice President gave an enlightening talk on *Automation for Boiler Plants*, after chapter officers had been announced. He explained the use and installation of boiler feeders when used with boiler controls, and described how two boilers could be hooked together with boiler water controls to maintain proper water level in each boiler. Mr. James also described the installation and application of low water cut-offs and pressure relief valves. A question period followed. Attendance 35.

• *KANSAS CITY*: Officers elected at the May meeting for 1955-56 are: *President* — A. S. Hurt, Jr.; *Vice President* — R. M. Spencer; *Secretary* — S. C. McCann; *Treasurer* — J. E. Miller; *Board of Governors* — F. K. Ladewig, J. R. De Rigne and R. B. Luhnow, Jr. Presiding officer for the first part of the meeting was Pres. F. K. Ladewig.

The newly elected president, A. S. Hurt, Jr., after accepting the gavel from the retiring president, presented an engraved certificate to Mr. Ladewig in appreciation of his good work on behalf of the chapter.

The speaker for the evening was P. W. Wyckoff, assistant chief engineer, Airtemp Division, Chrysler Corp., Dayton, Ohio. Mr. Wyckoff, who was introduced by J. S. Dukelow, spoke on *The Design and Performance of Waterless Air Conditioners for Residences*, and was very well received by members. Attendance 91. Attendance ratio 0.29.

• *MANITOBA*: The annual golf tournament, dinner and dance was held in June. At the dinner the new president, G. C. Davis, was introduced by the retiring president, G. T. Christie. Attendance 35.

• *MICHIGAN*: After the annual golf meet and dinner, officers were elected for the next year at the May meeting as follows: *President* — D. S. Falk; *Vice President* — J. N. Livermore; *Secretary* — J. H. Spitzley; *Treasurer* — P. S. Hosman; *Board of Governors* — C. J. Henstock, K. J. Wagoner and G. S. Whittaker. The new officers were inducted by G. W. Akers. Presiding officer for the first part of the meeting was the retiring president, E. F. Glanz. Attendance 115.

• *MINNESOTA*: Members at the May meeting voted in favor of a recommendation by Prof. A. B. Algren to make a contribution at the 1955 Semi-Annual Meeting in San Francisco, to the Society's Technical Advisory Committee on air cleaning. The donation is to be designated for work at the University of Minnesota.

The presiding officer, Pres. J. A. Craig, thanked chapter officers and committee chairmen for their cooperation throughout the past year, and accepted their final reports. Officers for the coming year were elected as follows: *President* — J. S. Locke; *Vice President* — E. T. Erickson; *Secretary* — F. G. Vogt; *Treasurer* — R. J. Ruth; *Board of Governors* — A. B. Algren and J. F. Siegel.

At the close of the business meeting President Locke introduced M. L. Oftedahl, who spoke on *Central Fan Systems*, and L. C. Gross, whose subject was *Unit Ventilators*. The two talks formed a debate on *Central Fan Systems or Unit Ventilators for School Heating and Ventilating*. Attendance 127.

• *MISSISSIPPI*: *A Climate for Learning* was the title of an interesting talk by C. A. Parker, Minneapolis-Honeywell Regulator Co., who was introduced by D. W. Urquhart. A discussion of the talk ended the meeting which was presided over by Pres. J. E. Davis, Jr. Attendance 23.

• *NEBRASKA*: Members present at the May meeting heard a very interesting talk on *High Velocity Air for Air Conditioning*. The speaker, C. M. Wilson, general sales manager, Anemostat Corp. of America, New York, N.Y., illustrated his talk with slides and took part in a question and answer period. He was introduced by M. F. Stober, program chairman. Pres. C. A. Goth presided at the meeting. Attendance 43.

• *NEW YORK*: A social hour and dinner preceded the May meeting at which

P. B. Gordon

retiring Pres. R. L. Stinard presided. Mr. Stinard introduced *ASRE* officers, R. C. Cross, secretary, G. R. Munger, technical secretary, and W. J. Wallace, Jr., managing editor. Mr. Cross is also former chairman of the ASHAE Committee on Research and former chairman of the Guide Committee. Albert Giannini, the incoming president, then accepted the gavel from Mr. Stinard, and P. B. Gordon, ASHAE second vice president, New York, N.Y., presented an inscribed plaque to Mr. Stinard in appreciation of his presidential services in the past year.

The speaker at the meeting, L. E. Varner, engineer, The Penn Mutual Life Insurance Co., Philadelphia, Pa., was introduced by President Giannini. Mr. Varner made a *Survey of Air Conditioning for Office Buildings* and reviewed the new Air Conditioning Guide prepared by the *Building Owners and Managers Association of Philadelphia* and the *Electrical Association of Philadelphia*. Mr. Varner also mentioned the several methods of air conditioning and their application to various types of buildings, and pointed out that the greatest expense in building operation is labor for cleaning and maintenance. The speaker concluded by showing a table of amortization and operating costs, and answered questions from the floor. He was given a rising vote of thanks for his very interesting presentation. Attendance 75.

• *NORTH JERSEY*: After a well-attended social hour and dinner, members at the May meeting heard a talk on the effects of wet- and dry-bulb temperatures, air movement and radiant heat in relation to personal comfort. The new president, C. H. Smith, introduced the speaker, K. E. Robinson, ventilating engineer, Research Laboratories Div., General Motors Corp., Detroit, Mich. Mr. Robinson illustrated his talk with slides, and concluded by taking part in a question and answer period. Before adjournment, the newly elected officers were formally installed by Past Pres. F. H. Faust. Attendance 81.

• *NORTH TEXAS*: The editor of *Oil Forum*, C. A. Neal, spoke on *Heating Abroad* at the May meeting presided over by Pres. J. A. Ray. Mr. Neal, born and reared in England, made a compressed survey of his subject and then launched into an entertaining dissertation encompassing the entire British Commonwealth, the views of the British man-in-the-street on the United States, and the character of the ordinary British citizen. Mr. Neal said that a complete understanding is necessary for both great countries to remain united in all future undertakings. Attendance 111. Attendance ratio 0.41.

• *NORTHERN OHIO*: Officers elected at the May meeting presided over by the retiring president, D. E. Mannen, are: *President*—L. C. Burkes; *Vice President*—H. R. Canoyer; *Secretary*—R. A. Urban; *Treasurer*—J. L. Frisse; *Board of Governors*—D. E. Mannen, R. E. Leising and J. R. Venning.

At the close of the business meeting, J. M. Black introduced W. G. Wassmandorf, assistant manager, refrigeration dept., The Trane Co., who spoke on compressor design and methods of refrigeration piping. Attendance 73.

• *OKLAHOMA*: An interesting talk on *A New Look at Thermal Insulation* was given by E. J. Stern, district manager, Armstrong Cork Co., Dallas, Tex., at the May meeting of the chapter. A question and answer session concluded the talk. The meeting was presided over by Pres. J. T. McKinney. Attendance 29. Attendance ratio 0.32.

Journal Section

• *OREGON*: The main speaker at the May meeting at which Pres. Dick Blankenship presided, was R. D. Tutt, chief engineer, Tuttle & Bailey, Inc., New Britain, Conn. Mr. Tutt, who was introduced by chapter Vice Pres. W. R. Norte, gave an informative talk on *Modern Trends in Air Distribution* and concluded with a question and answer period.

Prior to Mr. Tutt's talk, J. D. Kroeker spoke on public relations of the Society and chapter, its uses and effects. Attendance 78. Attendance ratio 0.31.

• *OREGON*: The president's annual report was given at the April annual meeting by retiring president, E. E. Kelly. Mr. Kelly briefly mentioned the work of the standing committees, the special committees and also the activities of the chapter officers and Board of Governors. He spoke of the progress made during the year, and thanked members for their help. B. W. Farnes then installed the new officers for the year, and a pair of engraved book-ends carrying the Society emblem was presented on behalf of the chapter to Mr. Kelly by the incoming Pres. Dick Blankenship. A bound copy of *Diffuser*, Vol. VIII was presented also to W. G. Woolley in recognition of his services as editor of the publication in the past year.

The speaker for the evening was P. L. Geiringer, chief engineer, American Hydrotherm Corp., Long Island City, N.Y. Mr. Geiringer gave an interesting talk on *High Temperature Fluid Heating Systems*, illustrated by slides. Attendance 89. Attendance ratio 0.40.

• *OTTAWA VALLEY*: Elected at the final meeting of the 1954-1955 season in May, are the following officers: *President*—E. J. Schoenherr; *Vice President*—N. J. Howes; *Secretary*—D. W. Banton; *Treasurer*—C. W. Watson; *Board of Governors*—G. A. Gray, J. W. Green and A. H. Hargreaves. The new president presented the retiring president, W. J. Robinson, with the Past President's Pin, and G. L. Ostiguy, on behalf of the chapter, presented him with an engraved silver tray.

A prominent Ottawa lawyer, Mr. McGovern, spoke after the business meeting on *Mechanic's Liens*. The speaker mentioned the history, scope and impact of the act, and ended by taking part in a lively question and answer session. Attendance 30. Attendance ratio 0.46.

• *OTTAWA VALLEY*: At the April meeting presided over by Pres. W. J. Robinson, nominations were acepted from the nominating committee for 1955-56 chapter officers. E. J. Schoenherr then introduced the speaker, G. L. Wiggs, senior partner, Wiggs, Walford, Frost and Lindsay, Consulting Engineers. Mr. Wiggs is also president of the Professional Engineers of Quebec, and formerly president of the Ottawa chapter and a member of the ASHAE council.

Speaking on *Hot Water Heating*, Mr. Wiggs listed the essential requirements of ideal heating systems, and gave a brief history of hot water heating developments in the past 140 years. The speaker gave his audience an insight into the design of high temperature systems, and showed slides of various buildings and installations illustrating points in his speech. Attendance 51. Attendance ratio 0.57.

• *PITTSBURGH*: After the retiring president, E. C. Hach, had expressed his thanks to chapter committees and their chairmen, the election of officers for the coming year was announced as follows: *President*—C. L. Benn; *Vice President*—R. M. Toucey; *Secretary*—E. H. Riesmeyer, Jr.; *Treasurer*—G. W. Cost; *Board of Governors*—R. J. Doherty and B. R. Small. After accepting the gavel, President Benn pinned the Past President's Pin on Mr. Hach. Attendance 48.

• *ROCKY MOUNTAIN*: The annual Ladies' Night meeting was held on May 4. The dinner and dance was arranged by Program Chairman, J. E. Harrington.

• *SACRAMENTO VALLEY*: The following officers were elected at the May meeting: *President*—R. A. Sarro; *Vice President*—V. W. Thornburg; *Secretary*—M. J. Delavan; *Treasurer*—S. W. Doolittle; *Board of Governors*—J. E. Marshall, E. B. Green and H. D. Brainard.

A talk on *The Fundamentals of Design and Application of Extended Fin Surfaces* was given by Albert Hanson, vice president, Drayer-Hanson, Div. of United States Radiator Corp., Los Angeles, Calif. Mr. Hanson, who was introduced by Mr. Sarro, discussed the factors which affect the performance of all extended fin surfaces, and the compromises all manufacturers must make between the theoretically ideal coil and the practical one.

• *ST. LOUIS*: At the 35th anniversary of the Chapter in May, G. H. Bemarkt announced the new officers as follows: *President*—E. T. Clucas; *Vice President*—W. P. Norris; *Secretary*—N. J. Hubbuch, Jr.; *Treasurer*—F. E. Ince; *Board of Governors*—G. H. Bemarkt, J. J. Blackmore, G. B. Pattiz, E. C. Kuntz, H. J. Kipp and W. D. Braden. After a short speech the retiring president presented Mr. Clucas with the gavel, and was in turn presented with the Past President's Pin by his successor. A rising vote of thanks was given to J. J. Blackmore for his services as editor of the chapter publication during the past year.

• *ST. LOUIS*: Reports of the nominating, membership and attendance committees, together with those of delegates to the *Joint Council of Engineering Societies of St. Louis* were heard at the April meeting at which Pres. G. H. Bemarkt presided.

A panel on the control of movement of air was the main feature of the evening, and two speakers were introduced by E. T. Clucas, program chairman, who also introduced the moderator, H. J. Kipp. The first speaker, C. H. Burnap, outlined the main points of high velocity air diffusion. He said three main reasons accounted for the popularity of this system—space saving, easy balance, and performance near to design. Mr. Burnap distributed a handbook on duct designing, and showed members a typical sound attenuating box used in the high velocity system.

The second speaker, H. C. Sharp, spoke on the low velocity systems, covering their development from the start of the present century. He said the proper selection of grilles gave a satisfactory movement of air in the comfort zone, and in addition he believed the induced movement of air was the only way to have air motion in the zone without creating drafts. Mr. Sharp further outlined the uses and effects of stripline diffusers and grilles. The meeting ended with a lively question period. Attendance 31.

• *SOUTH CAROLINA*: Two films on *How To Make Brass* and *Radiant Panels* were shown at the April meeting by Robert Mark, Chase Copper & Brass Co. Mr. Mark, who was introduced by the program chairman, H. L. McDowell, furnished the commentary during the showing of the films, and answered questions. Pres. R. F. Donovan presided at the meeting.

• *SOUTHERN CALIFORNIA*: Officers inducted at the June meeting were: *President*—J. L. McCullough; *Vice President*—H. F. Ulovec; *Secretary*—W. J. Biggar; *Treasurer*—A. Z. Levine; *Board of Governors*—I. F. Norcross; C. D. Walz, J. R. Hall, R. C. Taylor and R. W. Thomas.

After the inductions, members were taken on an imaginary tour of Disneyland, Walt Disney's fabulous entertainment park under construction in California. The speaker, J. S. Hamel, owner, J. S. Hamel-Engineer, Los Angeles, Calif., showed excellent slides of the 160-acre park, and discussed engineering problems involved with the animation of the cartoon characters. Mr. Hamel described the steam driven non-condensing engines used in the river boat, and the well-water distribution system for the park area. In conclusion, he ably handled the question and answer period. Mr. Hamel was introduced by J. R. Hall, program chairman, and the meeting was presided over by the immediate past vice president, J. L. McCullough, in the absence of past president C. D. Walz.

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Members of ASHAE
Moved or Moving?

Each month mail is returned BECAUSE you overlooked advising us of the change in your address.

The return mail is a loss to you, and an added expense to the Society.

In your own interest, will you please advise us at once of any change in your business or home address, indicating which is your mailing address.

ASHAE Headquarters
62 Worth St.
New York 13, N. Y.

• *SOUTHERN CALIFORNIA*: *Noise Control in Ventilation and Air Conditioning Systems* was the subject of a talk by D. B. Callaway, manager, western district, Industrial Sound Control, Inc., at the May meeting presided over by Pres. C. D. Walz. Mr. Callaway, who was introduced by Program Chairman J. R. Hall, reviewed the physical principles of noise abatement. He discussed the sources of noise and its methods of abatement, and showed slides indicating available ways of sound determination and calculation. The interest of the audience was demonstrated by the long question period at the end of Mr. Callaway's talk. Attendance 130. Attendance ratio 0.59.

• *SOUTHERN PIEDMONT*: An excellent talk was given on *The Heat Pump and Its Future Tomorrow* at the May meeting after formal business had been concluded. The speaker, Jim Partington, vice president and manager, C & H Distributing Co., Charlotte, N.C., was introduced by the program chairman, J. R. Clark. Presiding officer was Pres. L. F. Lawrence, Jr. Attendance 30. Attendance ratio 0.25.

• *SOUTHERN PIEDMONT*: George Rawlins, vice president, J. N. Pease & Co., spoke on *Water Resources of North Carolina* at the April meeting presided over by Pres. L. F. Lawrence, Jr. Mr. Rawlins, an authority on the subject with experience on State and local water committees, presented a precise, interesting talk on the reasons for conservation of water resouces in the state.

• *SOUTHWEST TEXAS*: The retiring president, L. H. Horner, Jr., made his farewell speech at the May meeting of the chapter. Mr. Horner expressed his appreciation for the work and cooperation of members and officers, and then gave way in favor of the incoming president, F. B. Frazee.

President Frazee introduced the speaker, H. I. Hoffman, research engineer, Southwest Research Center, San Antonio, Tex., who explained the work of the Center and discussed different phases and departments of research. The meeting ended with a question period. Attendance 24.

• *TOLEDO*: Officers elected at the May meeting, presided over by Pres. F. C. Richardson, Jr., are: *President*—C. F. Hoffman; *Vice President*—J. J. Heilman; *Secretary*—R. I. Fruth; *Treasurer*—R. O. Benington, Jr.; *Board of Governors*—G. H. Frost, F. A. Edgington and W. D. McKitrick.

J. F. Pugh introduced the speaker of the evening, J. M. Townsend, engineer, Servel, Inc., Chicago, Ill. Mr. Townsend spoke on *Evaporative Cooling* and concluded with a question and answer period. Attendance 54. Attendance ratio 0.52.

• *UTAH*: ASHAE executive secretary, A. V. Hutchinson, spoke at the April meeting on *The Engineer's Role in Public Life*. Mr. Hutchinson outlined the aims and functions of the Society, reminding members that it was the 62nd year they were organized to serve as *Engineers of Human Comfort*, and that this particular function should be better known to the general public.

Mr. Hutchinson described the research organization of the Society, alluding to the Research Laboratory which was started in 1919 in Pittsburgh, and moved to Cleveland in 1944. The speaker concluded by discussing the various publications of the ASHAE, the new individual subscriptions to *Heating, Piping & Air Conditioning*, and by making an appeal to members to make known to prospective members the aims of the Society. Mr. Hutchinson was introduced by Program Chairman R. C. Evans and thanked by Pres. A. A. Maycock, who presided. Attendance 32. Attendance ratio 0.50.

• *VIRGINIA*: A talk on *Construction Phases of the Old Point-Willoughby Tunnel* by R. B. Stevenson, resident engineer, Parsons, Brickerhoff, Hall & McDonald Co., was given at the May meeting. The speaker was introduced by A. B. Miller, and the presiding officer was T. B. Carpenter. Attendance 25. Attendance ratio 0.25.

• *VIRGINIA*: R. T. Doyle, Sr., secretary, Hastings Instrument Co., Hampton, Va., spoke at the April meeting on *Practical Use of Hot Wire Anemometers in Air Conditioning*. Pres. T. B. Carpenter presided at the meeting. Attendance 27. Attendance ratio 0.35.

• *WASHINGTON, D. C.*: The annual dinner dance was held in May. The retiring president, G. C. F. Asker, gave a short talk, and was then presented with the Past President's Pin by W. C. Reamy. Attendance 99.

• *WEST TEXAS*: An informative talk on water treatment was given at the June meeting by A. B. Featherstone, Worth Chemical Co., Fort Worth, Tex. Mr. Featherstone was introduced by the presiding officer, Pres. R. B. Carow. Attendance 18. Attendance ratio 0.40.

• *WEST TEXAS*: A talk on water shortages, meteorology and cooling towers was given by H. E. Degler, technical director, The Marley Co., Kansas City, Mo., at the May meeting presided over by Pres. R. B. Carow. Mr. Degler was introduced by V. B. Garry, program chairman. Attendance 35. Attendance ratio 0.40.

• *WEST TEXAS*: The guest speaker at the April meeting was V. F. Self, regional manager, Anemostat Corp. of America, New York, N.Y. He was introduced by V. B. Garry, and the presiding officer was R. B. Carow. Attendance 32. Attendance ratio 0.61.

• *WESTERN MICHIGAN*: ASHAE vice president, John W. James, Chicago, Ill., gave a short talk at the April meeting at which Pres. F. W. Brundage presided. President James discussed the HEATING, VENTILATING, AIR CONDITIONING GUIDE and also the comfort zone recommended by the Society.

D. W. Locklin introduced the main speaker for the evening, Richard Herbert, Primor Products, Inc., Adrian, Mich. Mr. Herbert covered several phases of air conditioning, beginning with the commercial problems in air cooling. He said the aim of all manufacturers of air cooling equipment is to make equipment which gives relative comfort for a reasonable price, and is quiet and economical to operate. Mr. Herbert concluded by discussing thermal storage, the size of air cooling equipment and the present trend toward air-cooled condensers. Attendance 87.

• *WESTERN NEW YORK*: Officers elected at the May meeting were as follows: *President* — C. W. Kaupp; *First Vice President* — Van Ness Harwood; *Second Vice President* — G. E. Kuhn; *Secretary* — J. P. Guerra; *Treasurer* — M. C. Beman; *Board of Governors* — Q. P. Thompson, M. C. Beman, Joseph Davis, Roswell Farnham and C. W. Stone. Retiring Pres. Q. P. Thompson then gave place to President Kaupp who presented him with the Past President's Certificate. Members at the meeting also gave Mr. Thompson a vote of thanks. Attendance 52.

• *WESTERN NEW YORK*: The chapter members travelled to Rochester for a joint April meeting with members in that area and made a tour of the Kodak Park Works of the Eastman Kodak Co.

The speaker later in the evening was Lawton Engleheart, assistant director of refrigeration, Eastman Kodak Co. Mr. Engleheart explained in greater detail some of the equipment seen at the plant. The presiding officer was Pres. Q. P. Thompson. Attendance 50.

• *WISCONSIN*: *Influence of Internal and External Moisture on Structures* was the title of a talk by L. V. Teesdale, Forest Products Laboratory, Madison, Wis. He spoke at the April meeting presided over by Pres. L. C. Plaehn and was introduced by C. H. Randolph.

Mr. Teesdale said the subject was applicable to homes rather than to business premises, as the former were built mainly of wood which was susceptible to moisture damage. Modern houses, said the speaker, use many features which contribute to excessive build-up of moisture inside causing condensation troubles, and most moisture troubles resulting from condensation can be eliminated by a moisture barrier, although none were 100 percent perfect. He recommended that high humidities should not be encouraged in houses not protected by a vapor barrier. Attendance 61. Attendance ratio 0.23.

Journal Section — Candidates for

The Society's By-Laws require that all applications for membership or advancement are to be sent to the Executive Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society, or mailed to all members. When the replies are received from references the Candidate's application shall be submitted to and acted upon by the Admission and Advancement Committee as soon as possible.

When the Admission and Advancement Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall confirm the election of the proposed Candidate for membership. During the past month there have been 66 applications, for membership, including 3 reinstatements; in addition 5 advancements have been received. The names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Admission and Advancement Committee, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Executive Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by August 31, 1955, these candidates will be voted upon by the Council. Those elected to membership will be notified by the Executive Secretary immediately after election.

Note: †Reinstatement. *Non-member. △Advancement.

California

ADAMS, F. E., Office Engr., J. W. Porter, Cons. Engr., San Jose. REFERENCES: H. H. Aiken, H. L. Gerber*, N. J. Kendall*, J. W. Porter*.

ADAMSON, J. A., Design Engr., Kilpatrick & Co., Alhambra. REFERENCES: R. M. Hennessy*, William Hovatan*, Faruk Konuk, J. P. Park.

FOX, S. W., Owner, Sanford W. Fox, Cons. Engr., Oakland. REFERENCES: K. F. Baldwin, B. H. Goon, N. H. Peterson, G. J. Yamas.

JOY, E. A., Assoc. Mech. Engr., Los Angeles Board of Education, Los Angeles. REFERENCES: E. C. Evans, S. W. Horton, R. C. Taylor, Albert Zimmerman.

PHILLIPS, R. W., Mech. Engr., G. S. Erskine, Cons. Engr., Sunnyvale. REFERENCES: Dudley Deane, D. A. Delaney, C. A. Gillet, Edward Hill.

SCHULTZ, F. W., Mgr. Electric Dept., Fairbanks, Morse & Co., Los Angeles. REFERENCES: E. C. Evans, C. E. Hollingworth, J. F. Park, T. H. Shonfeld.

†SWANSON, H. J., Plant Engr., Convair Div., General Dynamics Corp., San Diego. REFERENCES: R. S. Farr, Leo Hungerford, C. E. Parks, H. A. Smith*.

Connecticut

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Florida

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Georgia

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Idaho

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Illinois

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Kentucky

WALTON, W. W., Jr., Asst. Prof., University of Kentucky, Lexington. REFERENCES: Merl Baker, Merle Carter*, W. O. Gard*, E. B. Penrod*.

Louisiana

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Massachusetts

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Michigan

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Membership

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North Carolina

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Ohio

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Oregon

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Tennessee

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Texas

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BAKER, Z. L., Vice Pres., Baker Engineering Co., Lubbock. REFERENCES: R. B. Carow, O. P. Harlan, Jr., R. W. Hopper, R. A. Mixon.

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SELASKY, C. J., Sales Engr., Johnson Service Co., Lubbock. REFERENCES: H. V. Alexander, M. A. Benson*, F. C. McIntosh, K. A. Wright.

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Wisconsin

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△MENKE, A. C., Sales Mgr., Air Conditioning, The Trane Co., La Crosse. REFENCES: A. W. Edwards, R. G. Lubinsky, N. H. Peterson, C. L. Ringquist.

Canada

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BOOTH, I. R., Administrator, The British General Electric Co. (Canadian) Ltd., Montreal, Que. REFERENCES: S. P. Adkins, R. L. Douglas, R. H. Holbeche, R. E. J. Layton.

HALEY, A. W., Repr., Household Supplies, Canada, Ltd., Hamilton, Ont. REFERENCES: Henry Kreiter*, Robert MacDonald*, B. D. Paikin*, Jack Wilson*.

HARNOIS, R. A., In charge of Engrg. Dept., Saillaut, Inc., Quebec, Que. REFERENCES: Oscar Dorval, J. M. Paquet, L. P. Truchon, Jean Veilleux.

△OVEREND, G. B., Br. Mgr., Johnson Temperature Regulation Co. of Canada, Ltd., London, Ont. REFERENCES: W. T. Allen, Frank Alton, Jeff Kearn, W. L. Rootham.

STOTT, J. E., Cons. Engr., London, Ont. REFERENCES: A. B. Ballagh, Laird Hemphill*, F. D. Ledgett, G. B. Overend.

TAYLOR, E. W., Repr., Fiberglas Canada Ltd., Toronto, Ont. REFERENCES: D. L. Angus, L. M. Bennett, G. H. Hopper, F. W. Taylor.

Cuba

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OBITUARIES

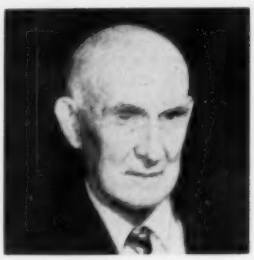
EDWIN A. SCOTT, FORMER SECRETARY OF SOCIETY, DIES AT 77

Edwin A. Scott, who served the Society as secretary in 1913 and gained prominence in trade journal publishing, died in Bronxville, N. Y. on June 26 after a long illness. Mr. Scott, who was 77 years old at the time of his death, served as secretary of the New York Chapter of the Society from 1919-20.

A publisher and editor of trade journals, Mr. Scott was chairman of the board of directors of Scott-Choate Publications, Tarrytown, N. Y., which publishes *Heating-Air Conditioning-Sheet Metal Contractor* (formerly *Sheet Metal Worker*), *The Journal of Plumbing, Heating and Air Conditioning, The Plumbing-Heating-Air Conditioning Wholesaler*, and *Air Conditioned Age*. He was also president of the Edwin A. Scott Publishing Corp., Tarrytown, trade manual and technical book publishers.

Born in Cardinal, Ontario, Canada, Mr. Scott came to the United States in 1900. He studied engineering at Columbia University, working in a foundry at the same time. He became associated with *Metal Worker, Plumber and Steamfitter* in 1907, and was managing editor from 1911 to 1914, when he joined the circulation department of *Iron Age*.

His first venture in publishing came in 1916 with the acquisition of *Sheet Metal*, which he merged four years later with another purchase, *Metal Worker, Plumber and Steamfitter*. In 1942, he became part owner



E. A. Scott

of *The Plumbing and Heating Journal*, acquiring full ownership the following year upon the death of a partner. Publication of *Air Conditioned Age* began this year.

Mr. Scott acted as code adviser during the National Recovery Administration for the sheet metal, roofing and warm-air heating industries. He had been chairman of the *Sheet Metal Contractors National Association*. Under the name A. J. Melish, he wrote two books on air conditioning; he was also the author of a number of technical papers.

Survivors of Mr. Scott are a son, E. A. Scott, Jr., who is an ASHAE junior member, and a daughter, Helen L. Scott.

CLAUDE B. SCHNEIBLE
Detroit, Mich.

The Society received word of the recent death of Claude B. Schneible at the age of 61. He was president of the Claude B. Schneible Co., Detroit, Mich.

Born in New York, N. Y. on December 28, 1893, he attended Northwestern University, receiving his M.E. in 1914. Before graduation, he started working with Joseph Schneible, chemical engineer. In 1915, he joined the Mott Sand Blast Manufacturing Co., Chicago, Ill. After three years in this employ, he became associated with National Carbon Co. Division, Union Carbide & Carbon Corp., New York, N. Y.

From 1919 to 1935, Mr. Schneible was connected with the American Foundry Equipment Co. (now American Wheelabrator & Equipment Corp.), Mishawaka, Ind. He formed the Claude B. Schneible Co. in 1935, incorporating twelve years later.

Mr. Schneible held many patents covering dust and fume control equipment. He was a member of *AFS*, *NFA*, and *FEMA*.

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● **GOLDEN GATE:** 1937. Hdqrs., San Francisco, Calif. Meets, 1st Thurs. PRES., D. E. McLeod, 2415 Green St. (23). SECY., Herb Duncan, 938 N. Linden Ave., South San Francisco.

● **ILLINOIS:** 1906. Hdqrs., Chicago, Ill. Meets, 2nd Mon. PRES., G. G. Freyder, 72 W. Adams St. (90). SECY., Herbert Kreisman, 117 N. Desplaines St. (6).

● **INDIANA:** 1943. Hdqrs., Indianapolis, Ind. Meets, 4th Tues. PRES., J. W. Jackson, 1531 N. Pennsylvania St. (2). SECY., G. W. Vogel, 31 E. Georgia St. (4).

● **INLAND EMPIRE:** 1950. Hdqrs., Spokane, Wash. Meets, 1st Mon. PRES., F. W. Jenkinson, 228 Hutton Bldg. SECY., J. A. Doyle, W. 3018 Broad.

● **IOWA:** 1940. Hdqrs., Des Moines, Ia. Meets, 2nd Tues. PRES., G. J. Kraai, 907 Sixth Ave. (14). SECY., W. A. Schworm, Physical Plant Dept., Iowa State College, Ames.

● **KANSAS:** 1951. Hdqrs., Wichita, Kan. Meets, Tues. after 1st Mon. PRES., Charles Yoe, P.O. Box 2239. SECY., T. L. Roberts, 2008 S. Parkwood Lane.

● **KANSAS CITY:** 1917. Hdqrs., Kansas City, Mo. Meets, 1st Mon. PRES., A. S. Hurt, Jr., 2119 Washington St. (8). SECY., S. C. McCann, 210 W. Tenth St. (5).

● **MANITOBA:** 1935. Hdqrs., Winnipeg, Man., Canada. Meets, 4th Thurs. PRES., G. C. Davis, 212 Waverly St. (9). SECY., A. H. Millar, 342 Mandeville St., St. James (12).

● **MASSACHUSETTS:** 1912. Hdqrs., Boston, Mass. Meets, 3rd Tues. PRES., G. W. Sprague, 108 Cummington St. SECY., W. G. Burbo, 137 Newbury St. (16).

● **MEMPHIS:** 1944. Hdqrs., Memphis, Tenn. Meets, 3rd Mon. PRES., John Hilton II, 4443 Sequoia. SECY., L. V. Eberle, Jr., 1358 Clementina.

● **MIAMI VALLEY:** 1950. Hdqrs., Dayton, Ohio. Meets, 1st Wed. PRES., D. E. Tullis, 1720 Parkhill Drive (6). SECY., L. P. Brehm, Jr., 111 S. Broomfield Rd.

● **MICHIGAN:** 1916. Hdqrs., Detroit, Mich. Meets, 1st Mon. after 10th of month. PRES., D. S. Falk, 4864 Woodward Ave. (1). SECY., J. H. Spitzley, 1200 W. Fort St. (26).

● **MINNESOTA:** 1918. Hdqrs., Minneapolis, Minn. Meets, 1st Mon. PRES., J. S. Locke, 2753 Fourth Ave., S. (8). SECY., F. G. Vogt, 6530 W. Lake St. (16).

● **MISSISSIPPI:** 1953. Hdqrs., Jackson, Miss. Meets, 4th Mon. PRES., J. E. Davis, Jr., P.O. Box 3216, West Jackson (7). SECY., L. H. Smith, 711 W. Capitol St.

● **MONTREAL:** 1936. Hdqrs., Montreal, Que., Canada. Meets, 3rd Mon. PRES., R. J. Ker, 5000 Namur St. (9). SECY., W. E. Jarvis, P.O. Box 61.

● **NEBRASKA:** 1940. Hdqrs., Omaha, Neb. Meets, 2nd Tues. PRES., C. A. Goth, Omaha National Bank Bldg. (2). SECY., L. J. Paulsen, 1901 S. 39th St.

● **NEW MEXICO:** 1954. Hdqrs., Albuquerque, N. M. Meets, 3rd Mon. PRES., H. F. Munn, 419 Granite, N.W. SECY., J. K. James, 4462 Avenida del Sol.

● **NEW YORK:** 1911. Hdqrs., New York, N. Y. Meets, 3rd Mon. PRES., Albert Giannini, 385 Madison Ave. (17). SECY., Carl H. Flink, 62 Worth St. (13).

● **NORTH JERSEY:** 1952. Hdqrs., Newark, N. J. Meets, 2nd Tues. PRES., C. H. Smith, 2300 N. Stiles St., Linden. SECY., M. C. Christesen, 196 Everett Pl., Englewood.

● **NORTH TEXAS:** 1938. Hdqrs., Dallas, Tex. Meets, 3rd Mon. PRES., J. A. Ray, 4411 Belmont Ave. (4). SECY., G. H. Meffert, 3328 Greenbrier Dr. (5).

● **NORTHEASTERN OKLAHOMA:** 1948. Hdqrs., Tulsa, Okla. Meets, 2nd Tues. PRES., J. T. McKinney, P.O. Box 5145 (16). SECY., G. A. McCune, 1908 Utica Square.

● **NORTHERN OHIO:** 1916. Hdqrs., Cleveland, Ohio. Meets, 2nd Mon. PRES., L. C. Burkes, 1792 E. 40th St. SECY., R. A. Urban, Sr., 1740 E. 12th St. (14).

● **NORTHERN PIEDMONT:** 1952. Hdqrs., Greensboro, N. C. Meets, 2nd or 3rd Fri. PRES., S. T. Oliver, 2307 Fairfield Ave. SECY., E. D. Frazier, 320 Ashland Dr.

● **OKLAHOMA:** 1935. Hdqrs., Oklahoma City, Okla. Meets, 2nd Mon. PRES., J. R. Patten, 1726 N.W. Fifth (6). SECY., A. C. Shelley, 2946 Nimitz (12).

● **ONTARIO:** 1922. Hdqrs., Toronto, Ont., Canada. Meets, 1st Mon. PRES., M. C. Bailey, 1139 Bay St. SECY., H. R. Roth, 57 Bloor St., W.

● **OREGON:** 1939. Hdqrs., Portland, Ore. Meets, Thurs. after 1st Tues. PRES., Dick Blankenship, Cascade Bldg. (4). SECY., W. B. Hayes, 707 Portland Trust Bldg. (4).

● **OTTAWA VALLEY:** 1952. Hdqrs. Ottawa, Ont., Canada. Meets, 3rd Tues. PRES., E. J. Schownherr, 32 Clarey Ave. (1). SECY., D. W. Banton, 360 Richmond Rd. (3).

● **PACIFIC NORTHWEST:** 1928. Hdqrs., Seattle, Wash. Meets, 2nd Tues. PRES., P. I. L. Winsor, 20031 Marine View Dr., S.W. (66). SECY., M. W. McKinstry, 4017 McGilvra St. (2).

● **PHILADELPHIA:** 1916. Hdqrs., Philadelphia, Pa. Meets, 2nd Thurs. PRES., A. M. Robertson, 1200 Locust St. (7). SECY., R. J. Sigel, 822 Montgomery Ave., Narberth.

● **PITTSBURGH:** 1919. Hdqrs., Pittsburgh, Pa. Meets, 3rd Mon. PRES., C. L. Benn, 420 Blvd. of Allies (19). SECY., E. H. Riesmeyer, Jr., 231-33 Fort Pitt Blvd. (22).

● **ROCKY MOUNTAIN:** 1944. Hdqrs., Denver, Colo. Meets, 1st Wed. PRES., L. L. DeLong, 2027 S. Washington St. (10). SECY., W. V. Burbank, P.O. Box 840.

● **SACRAMENTO VALLEY:** 1952. Hdqrs., Sacramento, Calif. Meets, 1st Wed. PRES., R. A. Sarro, 5412 Argo Way (21). SECY., M. J. Delavan, 405 Meister Way (19).

● **ST LOUIS:** 1918. Hdqrs., St. Louis, Mo. Meets, 2nd Tues. PRES., E. T. Clucas, 4354 Olive St. SECY., N. J. Hubbuch, Jr., 1706 Olive St. (3).

● **SHREVEPORT:** 1948. Hdqrs., Shreveport, La. Meets, 3rd Thurs. PRES., R. S. Segall, 848 River Rd. SECY., A. L. Jones, Jr., 753 Gladstone.

● **SOUTH CAROLINA:** 1954. Hdqrs., Columbia, S. C. PRES., R. K. Rouse, P.O. Box 3731, Greenville. SECY., B. A. Leppard, P.O. Box 3294, Station "A," Greenville.

● **SOUTH TEXAS:** 1938. Hdqrs., Houston, Tex. Meets, 3rd Fri. PRES., J. W. Holland, 245 Esperson Bldg. (2). SECY., J. C. Lewis, Box 8188.

● **SOUTHERN CALIFORNIA:** 1930. Hdqrs., Los Angeles, Calif. Meets, 1st Tues. PRES., J. L. McCullough, 1978 S. Los Angeles St. (11). SECY., W. J. Biggar, 6620 Telegraph Rd. (22).

● **SOUTHERN PIEDMONT:** 1952. Hdqrs., Charlotte, N.C. PRES., L. F. Lawrence, Jr., 212 Greystone Rd. SECY., G. C. Garrett, P.O. Box 3697.

● **SOUTHWEST TEXAS:** 1946. Hdqrs., San Antonio, Tex. Meets, 3rd Tues. PRES., F. B. Frazee, 1013 Riverside Dr., Austin (4). SECY., J. L. Rea, Jr., 300 West 8th St., Austin.

● **TOLEDO:** 1954. Hdqrs., Toledo, Ohio. PRES., C. F. Hoffman, 523 Spitzer Bldg. (4). SECY., R. I. Fruth, 1316 Adams St. (2).

● **UTAH:** 1944. Hdqrs., Salt Lake City, Utah. Meets, 3rd Thurs. PRES., A. A. Maycock, P.O. Box 36 (10). SECY., W. L. Stuewe, 1472 S. State St. (4).

● **VIRGINIA:** 1946. Hdqrs., Norfolk, Va. Meets, 3rd Wed. PRES., T. B. Carpenter, 8400 Millard St. SECY., C. G. Conaway, Jr., 4701 Colley Ave. (5).

● **WASHINGTON, D. C.:** 1935. Hdqrs., Washington, D. C. Meets, 2nd Wed. PRES., W. C. Reamy, Jr., 720 Mills Bldg. (6). SECY., S. H. Robbins, Jr., 2117 M Street, N.W. (7).

● **WEST TEXAS:** 1953. Hdqrs., Lubbock, Tex. Meets, 1st Tues. PRES., R. S. Carow, P.O. Box 3206. SECY., H. L. Mayes, P.O. Box 151.

● **WESTERN MASSACHUSETTS:** 1955. Hdqrs., Springfield. PRES., R. E. Cross, 114 Boston Rd. SECY., F. A. Ferraro, 172 Chestnut St.

● **WESTERN MICHIGAN:** 1931. Hdqrs., Grand Rapids, Mich. Meets, 2nd Mon. PRES., F. W. Brundage, 512 N. Park St., Kalamazoo (11). SECY., F. L. Murray, 482 W. Michigan Ave., Battle Creek.

● **WESTERN NEW YORK:** 1919. Hdqrs., Buffalo, N. Y. Meets, 2nd Mon. PRES., C. W. Kaupp, 271 Delaware Ave. (2). SECY., J. P. Guerra, 96 Cottage St. (1).

● **WISCONSIN:** 1922. Hdqrs., Milwaukee, Wis. Meets, 3rd Mon. PRES., I. J. Rossiter, 231 W. Wisconsin Ave. (3). SECY., R. D. Rodwell, 4781 N. Elkhart Ave. (11).

SPECIAL BRANCH

● **SWITZERLAND:** 1952. Hdqrs., Zurich. PRES., H. C. Bechtler, Anemonenstrasse 40 (47). SECY., Walter Hausler, Erbstrasse 2, Kusnacht.

STUDENT BRANCHES

● **NORTH CAROLINA STATE COLLEGE:** 1948. Hdqrs., Raleigh, N. C. PRES., Alvah Ehrman, Box 4502, State College Station. SECY., R. W. McDonald, 1010½ Vance St.

● **OKLAHOMA A. & M. COLLEGE:** 1950. Hdqrs., Stillwater, Okla. PRES., C. E. Durrett, 1215 College. SECY., R. M. Jauch, 308½ W. Maple.

● **OREGON STATE COLLEGE:** 1949. Hdqrs., Corvallis, Ore. Meets, 1st Wed. after 1st Tues. PRES., P. I. Anderson, 202 N. 10th. SECY., D. W. Strahan, 233 Mall St.

● **PURDUE UNIVERSITY:** 1948. Hdqrs., W. Lafayette, Ind. PRES., D. B. Doucette, Purdue Student Branch, ASHAE, School of Mech. Engrg. SECY., J. W. Deabler, Purdue Student Branch, ASHAE, School of Mech. Engrg.

● **TEXAS A. & M. COLLEGE:** 1946. Hdqrs., College Station, Tex. Meets, 2nd and 4th Tues. PRES., D. F. Carroll, Box 6264. SECY., C. W. Farrar, Jr., Rt. 1, Box 339, Bryan.

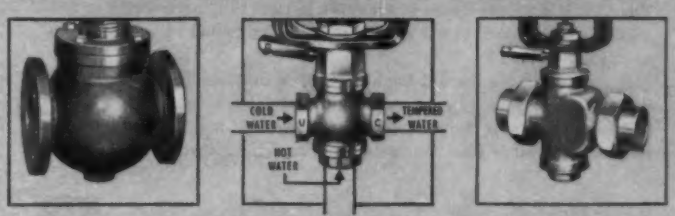
● **UNIVERSITY OF DETROIT:** 1949. Hdqrs., Detroit, Mich. Meets, 1st Tues. PRES., J. C. Rumpf, 16511 Muirland (21). SECY., L. J. Hayes, Jr., University of Detroit.

● **UNIVERSITY OF TEXAS:** 1949. Hdqrs., Austin, Tex. Meets, 1st and 3rd Tues.

● **UNIVERSITY OF TORONTO:** 1951. Hdqrs., Toronto, Ont., Canada. PRES., W. A. Stewart, 86 Roxborough St., W. (5). SECY., R. M. Davies, 144 Manor Rd., E.

POWERS No. 11 Self-Operating TEMPERATURE REGULATOR

Automatically holds temperature constant at the right point. Prevents losses caused by wasteful OVER-heating.

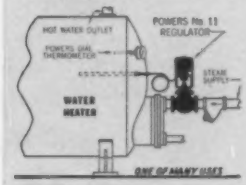


Various Valve Bodies and Inner Valves are available. Single and Double Seat Valves thru 2" have rugged bronze bodies with bronze union connections for quick, easy installation. Bulletin 329 gives information about all types.

(e88)

Why It Gives BETTER CONTROL and Saves More Money

Often repays its cost 3 to 6 times a year when used on:



Water Heaters
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Industrial Processes
—
Heat Exchangers
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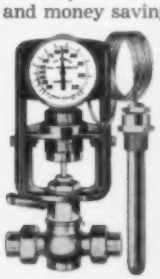
Fuel and Crude Oil Heaters
—
Air Compressors Diesel Engines

ONLY POWERS No. 11 REGULATOR Offers ALL These Advantages

- **Simple, sturdy construction.** Materials used are corrosion resistant.
- **Powers bellows has 50% more power** than used in the majority of regulators. The heart of a self operating regulator is its bellows. Powers with its 50% greater effective area gives better control and its durable 2 ply bellows outlasts ordinary single ply bellows.
- **Valve stem lubricator** with silicone grease aids easy movement of highly polished stainless steel valve stem and reduces drying out of packing.
- **BETTER CONTROL** results from Powers powerful bellows and minimum of valve stem friction.
- **60°F. temperature ranges** available with accuracy of ±1°F. on some processes and 2 to 3°F. on others.
- **Rugged bronze valve bodies with bronze union connections,** for single and double seat valves thru 2", reduce installation time and labor. Larger sizes have flanged iron body valves.
- **Powers Nationwide Service and 24 Hour Delivery** in the U.S.A. are important time and money saving advantages.



- **Indicating Regulator** with easy to read 4" dial thermometer helps adjust the regulator and check temperature at the bulb. Various dials and ranges are available.

Right type and size of valve is important for good control. May we help you make the right selection? Benefit from POWERS more than 60 years experience with self-operating regulators.

Call our nearest office or write us direct for Bulletin 329.

THE POWERS REGULATOR CO.

Skokie, Ill. | Offices in Chief Cities in U.S.A.
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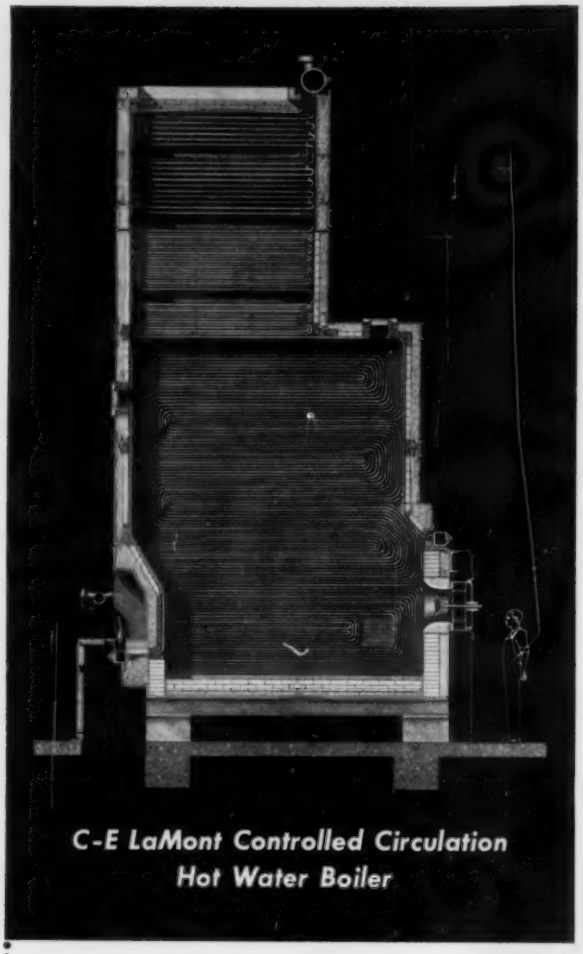
Established 1891



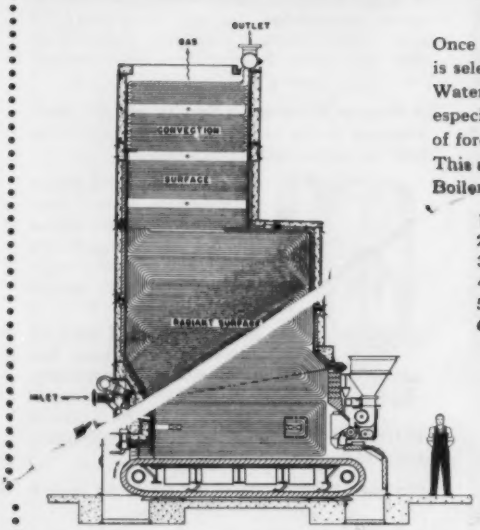
C-E LaMont Controlled Circulation Hot Water Boiler

EVER CONSIDER HIGH TEMPERATURE WATER FOR YOUR HEATING AND PROCESSING NEEDS?

Both steam and high temperature water have their place, and your particular requirements will determine which is best for you. In either case the complete C-E line includes a type and size of boiler exactly suited to your requirements. Where high temperature (HT) water seems indicated, it affords such important advantages as:

1. The higher available heat in HT water... many times that of steam at the same pressure.
2. Closer control of temperatures throughout the system.
3. Heat loss is minor with the HT water closed system... no condensate losses... unused heat returns to the boiler.
4. No elaborate feedwater treatment required because make-up requirements are small.
5. No steam traps are needed, which means elimination of all trap problems and attendant expense.
6. No blowdown losses... no safety valve vent losses... no condensate return lines.

The planning of any new heating and/or processing system should give proper consideration to the suitability of the HT water system. There are many hundreds of HT water installations operating abroad and a rapidly growing number in the U.S.A. It may be *just right* for *your* requirements.



Advantages of the C-E Hot Water Boiler

Once it is established that HT water is right for your needs, your next concern is selection of proper equipment. The C-E LaMont Controlled Circulation Hot Water Boiler has inherent advantages that make it the best possible choice. It is especially designed for HT water applications utilizing as it does the principle of forced, controlled circulation which is extended throughout the entire system. This accounts for numerous points of superiority in the C-E LaMont Hot Water Boiler. Among these are:

1. Complete control over HT water movement in both system and boiler.
2. Low pressure loss is inherent so no separate boiler pump is required.
3. Pressurized operation with oil or gas means no induced draft fan — simple stack.
4. Single-pass design — no baffles... low draft loss... cleaner boiler.
5. More efficient heating surface can be arranged because of positive, controlled circulation.
6. Other features such as: steel enclosed setting — few headers, all accessible — any fuel, oil, gas or coal.

The C-E Hot Water Boiler is available in sizes ranging from 15 to 200-million Btu per hour, or more, with pressures up to 300 psi and temperatures to about 425 F.

If you are in the market for a heating or process system — or expect to be — by all means investigate high temperature water and the C-E LaMont Hot Water Boiler. Our engineers will be pleased to discuss the subject with you or your consultants. Write for our new catalog HT-207.

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BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

CLEAN AIR ELECTRONICALLY

THE Electro-STAYNEW WAY

Eliminate SMOKE, AIRBORNE DUST, POLLEN

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WITH Electro-STAYNEW PRECIPITATORS

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Give your plant tested, economical clean air protection.

Based on the "electrostatic principle of precipitation", (+) charged dirt drawn to (−) charged collector plates, Electro-Staynew *removes more than 90% of dirt particles* and returns clean air. Dust, smoke, soot and microscopic particles (as small as 1/250,000 of an inch in diameter) are removed. Electro-Staynew improves efficiency, quality-control, and its extremely low maintenance cost makes operation economical.

Unclean Air

Mechanically Clean Air

Electronically Clean Air

for the HOME

Announcing An Electro-Staynew For A More Comfortable Home!

Easily installed in any forced air circulating system, the compact Electro-Staynew Home Precipitator distributes air with *over 90% dust, dirt, pollen removed.* The *same electrostatic filtration* used so successfully in other Electro-Staynew units will reduce cleaning and fuel costs. The Electro-Staynew Home Precipitator brings symptomatic relief to persons allergic to airborne particles. It's economical to operate . . . actually uses less current than a 50 Watt light bulb!

Operates on standard electric house current.

No moving parts to get out of order.

Write for Bulletin 400—Electro-Staynew Industrial Precipitator
Bulletin 440—Electro-Staynew Home Precipitator

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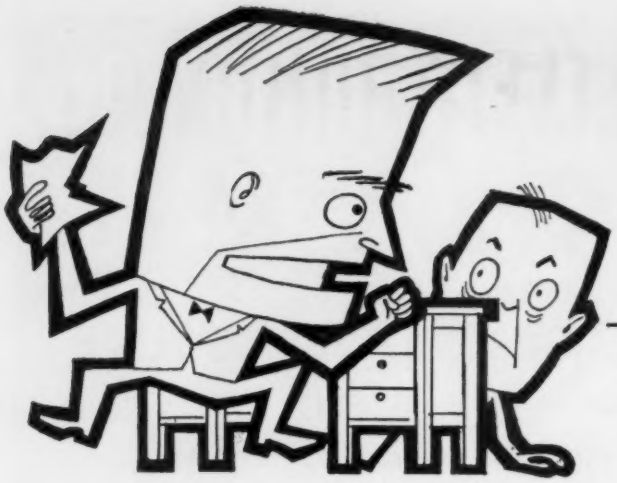
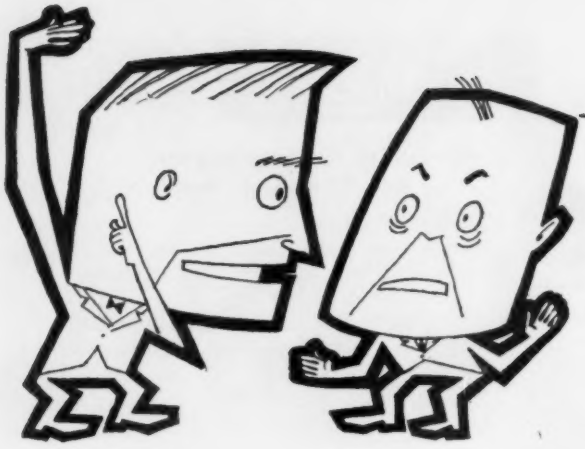
ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



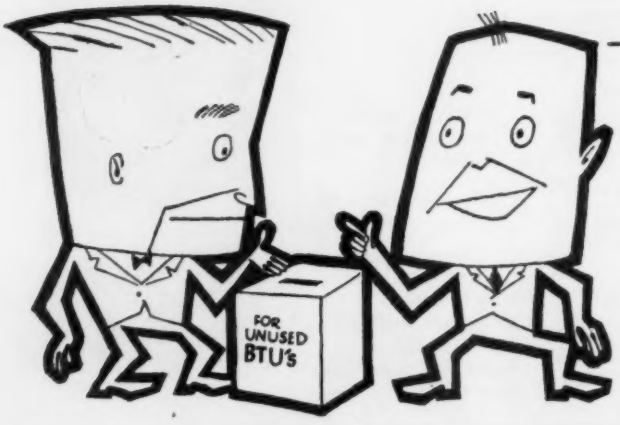
Fire the fireman! Here's another smoke summons.

Don't fire the fireman, he's doing his best. Let us look for a more adaptable coal.



What's wrong with the coal? It's high in BTU's.

Sure, it's a good coal—in the right furnace—but our set-up just can't supply enough air to burn all of the hydrocarbons before they cool off and blow up the chimney as free carbon.



There's no sense in buying BTU's we can't burn, is there?

You've got a point there—and one that so many people are never aware of. It isn't only what's in the coal that counts—it's what you can get out of it under your own set of conditions. That's why picking the right coal is a job for a competent combustion engineer. The superior quality coal produced at mines served by the Chesapeake and Ohio will meet our most exacting requirements. Before we sign another coal contract, let's get in touch with coal producers on the C&O or a C&O coal man to give us the facts and figures on which coal will cost us least in the long run.

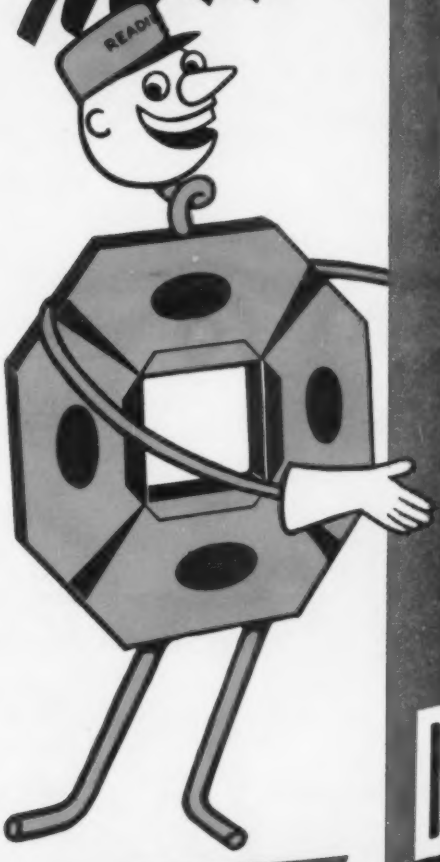
P.S.

There's a lot more to buying coal than the cost per ton. For facts and figures to solve your particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

NOW-Mr. Readi-Pakt offers:



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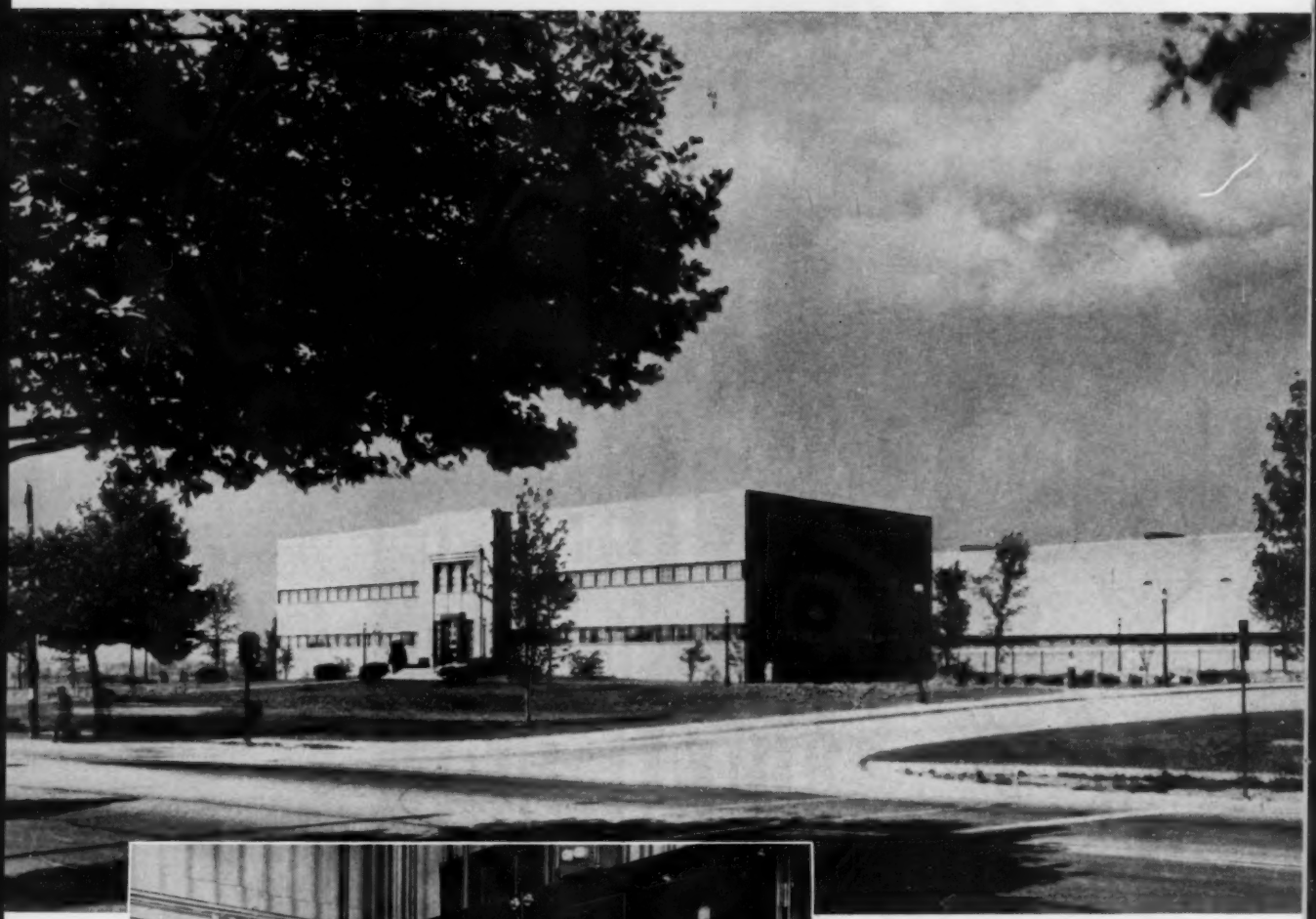
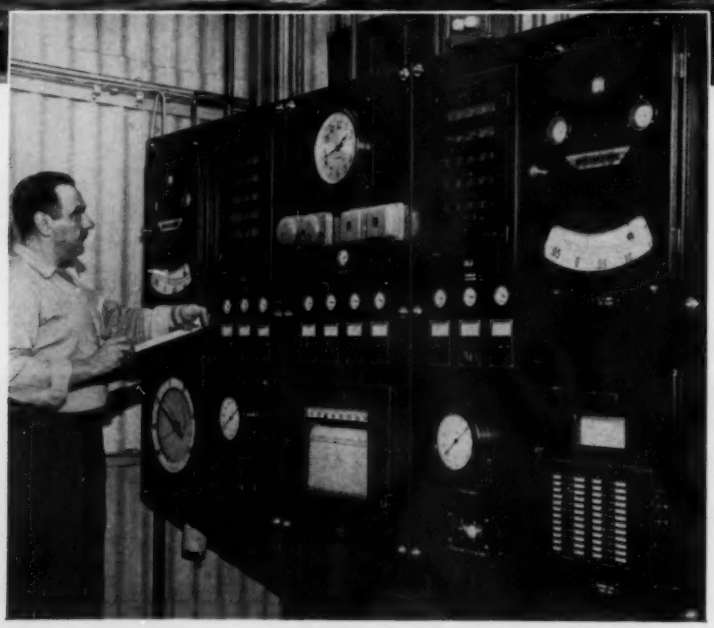




CONTROLLED CLIMATE PROTECTS PRECISION. *Allentown, Pa. plant of Western Electric Company profits by accurately controlled air temperature and humidity . . . for maintenance of freedom from dirt, dust and perspiration that could damage delicate electronic components.*

AIR HANDLING CONTROL CENTER. *Brown instruments on this main control panel provide fingertip control of static air pressure within the buildings, control of intake and recirculation dampers, and a ready check on temperatures in plant areas and of outside atmosphere.*

system centralized

by Brown instruments

EFFICIENT overall supervision of an air handling system is a process control problem . . . for which Brown instrumentation offers an effective solution.

Here's a typical example of how this idea works. At the ultra-modern electronics plant of Western Electric Company, Allentown, Pa., four different manufacturing areas require close control of air temperature and humidity in order to assure consistently high quality of production. Two office areas are also air conditioned.

The manufacturing and office areas are divided into nineteen units, each supplied by its own air handling system and independently controlled by Honeywell thermostats in hot and cold ducts, *Grad-U-Stats* and *Humidistats* in individual zones within the area, and pneumatically operated steam and cooling water valves.

To supplement the on-the-spot area controls, a panel of Brown instruments gives the plant engineer a concentrated picture of the operation of the entire plant's air conditioning. At a glance, he can see outside air temperatures, both wet and dry bulb . . . continuously recorded on a wide chart. He can spot-check up to 48 different inside temperatures, just by pressing push-buttons. And for overall operation, he has a pair of Brown controllers for regulating static pressure within the buildings, and an *ElectroniK* controller for adjusting fresh air intake and recirculation dampers.

The accurate, centralized way in which this vital data is displayed makes for maximum efficiency in supervision . . . maximum economy in use of steam, water and power.

Any air handling system can reap these same benefits through the application of Brown instruments. The range of instrument types and ranges covers any variable encountered in modern system operation . . . temperature, humidity, pressure, flow . . . in a variety of indicating, recording and controlling functions. All are developed, manufactured and custom-engineered by Honeywell . . . the world's largest manufacturer of controls. You profit by this single responsibility for *all* control needed throughout the entire installation.

For a discussion of how these instruments can centralize control in your specific system, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

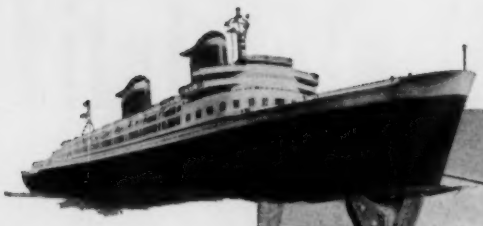
H HONEYWELL

MINNEAPOLIS **Honeywell**

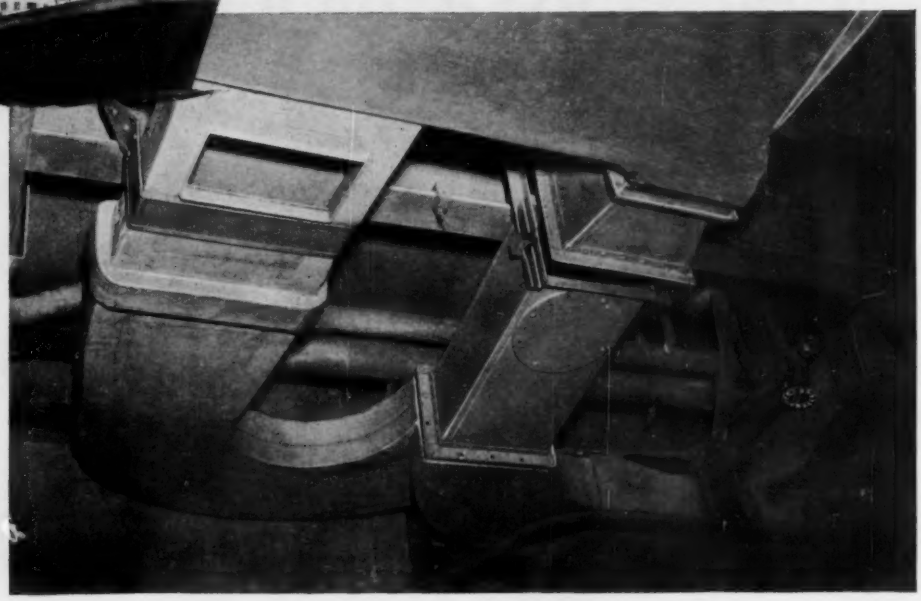
BROWN INSTRUMENTS

First in Controls

● **REFERENCE DATA: Write for Catalog S1810A, "Brown Instruments Applied to Commercial Air Handling Systems."**



On the air conditioning ducts aboard the S.S. United States . . .



These Spintex insulated ducts are a vital part of the 65 air conditioning systems that honeycomb the new superliner S. S. United States.

NEW J-M *Spintex* INSULATION CONSERVES FUEL AND POWER

MILES OF DUCTS . . . a vital part of the 65 air conditioning systems that honeycomb the S. S. United States . . . are insulated with Johns-Manville Spintex. This insulation was selected because it makes possible maximum passenger comfort at minimum operating cost.

Low thermal conductivity . . . plus resistance to moisture, fire, rot and mold growth . . . make Spintex the most effective insulation for guarding against heat transfer and moisture accumulation.

Spintex in flexible and semi-rigid types, plus rigid Rock Cork* and Zerolite*, form a team of Johns-Manville insulations for air conditioning ducts that meet every industrial requirement. Basically mineral products, each insulation has its particular characteristics that make it specially suitable for a specific air conditioning service. All three have the low heat transfer properties needed for high insulating efficiency. Properly installed, these insulations for air conditioning ducts will perform their function effectively for the entire life of the equipment on which they are applied.

Since proper application is so essential to the peak performance of any insulation, Johns-Manville offers industry the services of experienced installation contractors who have made a career of solving complex insulation problems.

J-M Insulation Engineers and J-M Insulation Contractors are conveniently located. They stand ready to combine their talents and give you an insulation job that will pay off your initial investment with maximum fuel savings.

Why not let us send you a free copy of Brochure IN-135A which gives all the facts about Johns-Manville Insulations for Air Conditioning Ducts? Write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

*Reg. U. S. Pat. Off.

Applying Johns-Manville Spintex insulation on one of the ducts aboard the S. S. United States during construction at the Newport News Shipbuilding and Dry Dock Company. Johns-Manville Insulation Contractors throughout the country know Spintex and other J-M insulations as *quality* products, and take pride in applying them properly for peak performance.

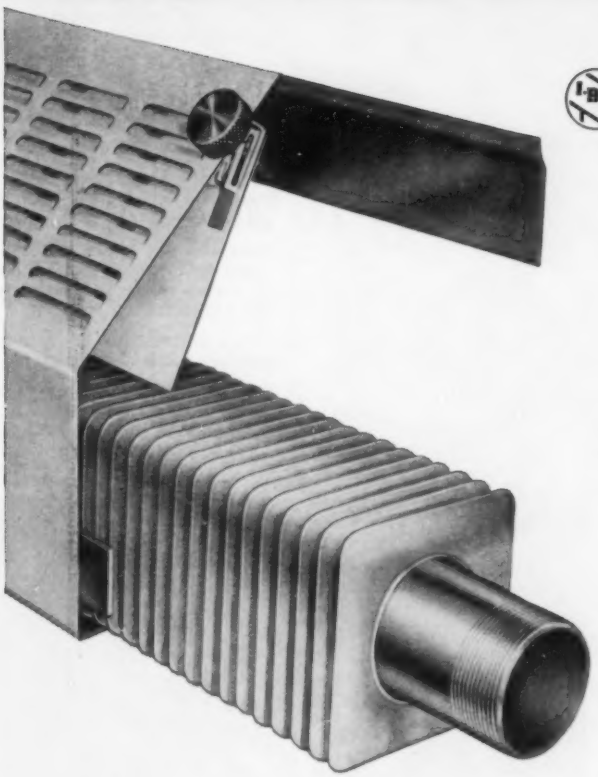
Johns-Manville *FIRST IN* INSULATION

MATERIALS • ENGINEERING • APPLICATION

SARCOFIN

When you buy or specify radiation

make sure you get all these advantages!



Sarcofin offers you:

APPROVED RATINGS—as established by Institute of Boiler and Radiator Manufacturers for finned-tube and baseboard radiation.

FULL GUARANTEE—top-quality Sarcofin products, backed up by a *1-year guarantee* against defects in materials and workmanship. Heating elements *guaranteed* for maximum working pressures.

COOPERATION—careful selection of radiation by experienced Sarco and Sarcotherm heating engineers.

UNDIVIDED RESPONSIBILITY—the protection and convenience assured by obtaining from *one* "Complete Line" source...SARCO-SARCOTHERM... not only Sarcofin finned-tube and baseboard radiation but also heating specialties for steam and hot water, condensation and vacuum pumps, temperature regulators, and weather-compensated control systems for steam and hot water heating.

SARCO COMPANY, INC.
SARCOTHERM CONTROLS, INC.
Empire State Building, New York 1, N. Y.

MAIL COUPON FOR THESE BULLETINS

Sarco Company, Inc.—Sarcotherm Controls, Inc.
Empire State Building, New York 1, N. Y.

Please send me:
☐ 32 page Bulletin No. 1650 on Sarcofin Finned-Tube Radiation.
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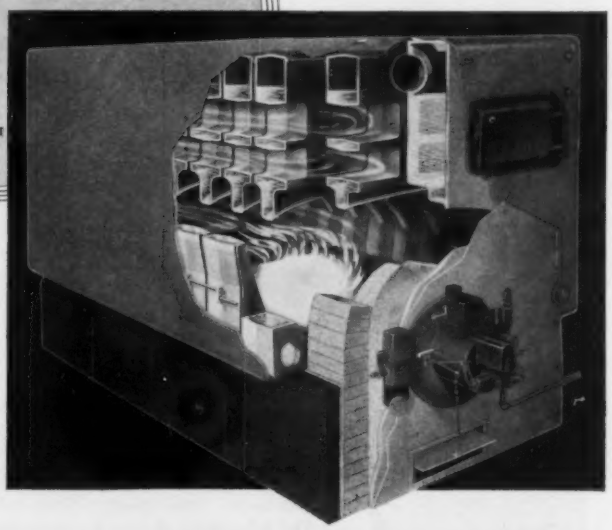
4005-B

GET THE FACTS ON THE FIRST *CAST IRON* BOILER DESIGNED FOR HORIZONTAL ROTARY OIL BURNERS!

SERIES HR BOILERS *FEATURING...*

1. Large fire box volume for better combustion conditions and maximum radiant heat transfer.
2. High base for more combustion space and elimination of high brick foundation.
3. Special steel front plate for simplifying installation of rotary burners. Openings in plate can be cut at factory for specific makes of burners.
4. Green enamelled steel jacket lined with thick blanket of fibre glass—saves insulating time.
5. Balanced gas travel through flueways for equal distribution of heat to all secondary heating surfaces.
6. Large waterways for rapid, efficient water circulation.
7. Individual short draw rods for easy, strain-free assembly. Sectional construction for easier installation.



DESIGNED IN COOPERATION WITH LEADING MAKERS OF ROTARY OIL BURNERS

Weil-McLain Series HR Heavy Duty Boilers effectively develop the economies obtainable with horizontal rotary cup oil burners. Their specialized design fulfills the two basic requirements of high operating efficiency—*ample combustion volume and a high percentage of primary heating surface!*

Send for catalog No. C-188—see the design, construction and operating features which make the Series HR Boiler a genuine advance in oil burning efficiency.

WEIL-McLAIN BOILERS · RADIATORS

WEIL-McLAIN COMPANY
MICHIGAN CITY, INDIANA

Address literature requests to Dept. AA-85

This recently completed housing development at Flushing, N. Y., is called the Mitchell Cooperative Apartments. Beth-Co-Weld steel pipe was used extensively for the plumbing and heating lines. *Contractor:* Jarcho Bros., Long Island City, N. Y.; *Jobber:* Chas. F. Guyon, Inc., New York.

New Buildings with Beth-Co-Weld

For any type of residential or industrial construction, Beth-Co-Weld is ideal steel pipe for general-purpose applications.

Beth-Co-Weld is good, reliable pipe for plumbing and heating lines because it is made from sound steel by the continuous-weld process. It's uniform pipe in every way—in quality, in physical characteristics, and in strength of weld.

Your jobber stocks Beth-Co-Weld steel pipe in sizes from ½ in. to 3 in., standard-weight and extra-strong, in random lengths, and in 21-ft uniform lengths, plus or minus 1 in. He also furnishes Beth-Co-Weld in 3½ and 4 in., standard weight only, in lengths of approximately 22 ft.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Miles of Beth-Co-Weld are used in heating and plumbing lines at new Mercy-Douglass Hospital, Philadelphia. *Contractor:* L. E. Winter Co; *Jobber:* C. J. Rainear and Co., Inc., both of Philadelphia.

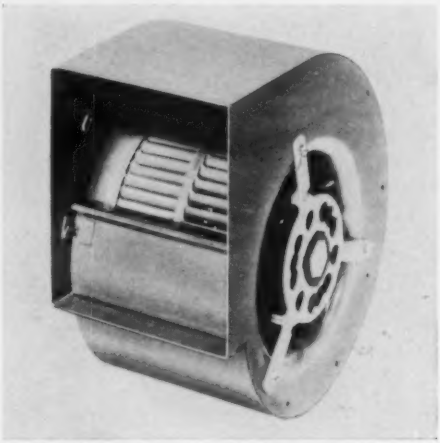
BETHLEHEM STEEL

BETH-CO-WELD STEEL PIPE

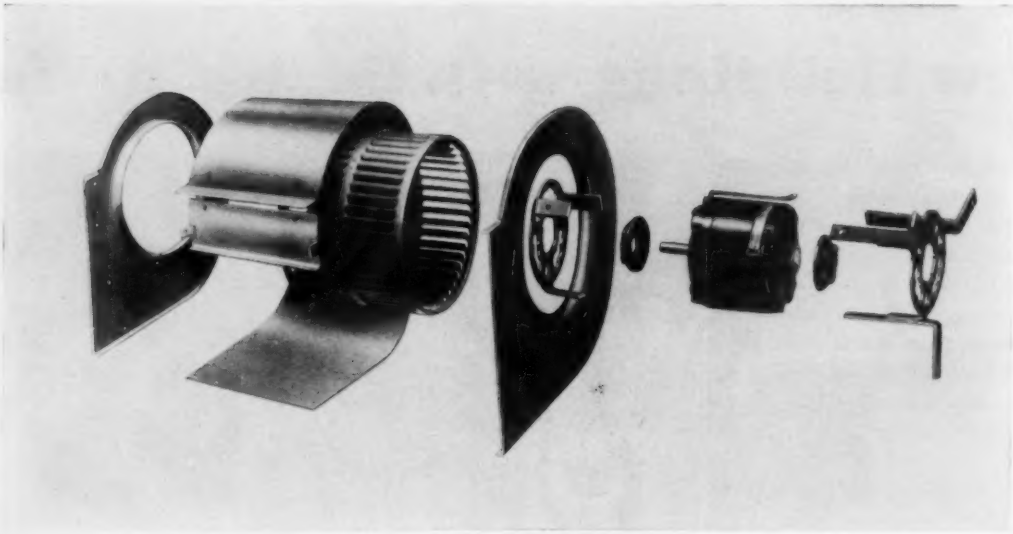
Many Original Equipment Manufacturers are

Changing to Direct Drive Blowers

Buying MORRISON PARTS and building their own blower assemblies... or buying Morrison Complete Assemblies.



SPEED CONTROL OPTIONAL



Morrison Direct Drive Blowers . . .
require less space,
need no unnecessary accessories,
reduce vibration.

They assure maximum efficiency and quiet operation at a *substantial saving in cost.*

Buy MORRISON PARTS and make your own assemblies, or buy the complete assemblies. In either case, manufacturers of Original Equipment know that MORRISON correct design and extra heavy construction is unsurpassed. *Better Investigate the Direct Drive.*

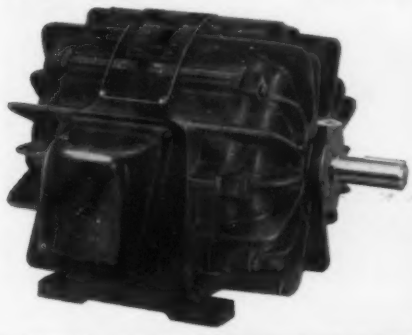
• ***Write for Literature TODAY***

MORRISON PRODUCTS Inc.

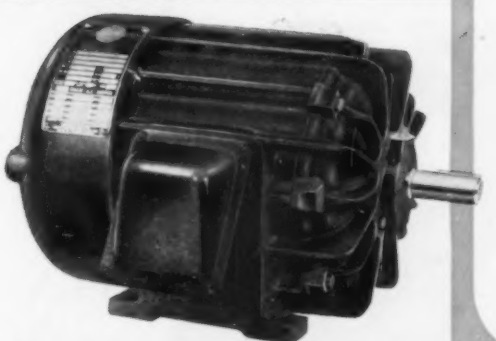
16816 Waterloo Road • Cleveland 10, Ohio

DUST-PROOF!
MOISTURE-PROOF!

TWO NEW "DIEHL MOTORS FOR Air-Over-Motor" APPLICATIONS



Type "DIE" Motor (Not Fan-Cooled)



Type "DIF" Motor (Fan-Cooled)

Tops in Quality — Competitive in price!

When you buy or specify motors for fans, blowers, unit heaters, air conditioners, cooling towers or dehumidifying systems *don't overlook* these two new standard or custom-designed Diehl Totally-Enclosed Motors.

Smaller in size, lighter in weight, precision-engineered and precision-built to new NEMA standards, they are ideally suited to "air-over-motor" applications where moisture, fumes, dust and other airborne particles are a problem ... a field in which Diehl has long been a leader.

Diehl

Visit us at Booth No. 429 at the
THE PRODUCTION ENGINEERING SHOW
(the Automation Exposition)
Navy Pier, Chicago
September 6-16, 1955

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING COMPANY
Finderne Plant, SOMERVILLE, N. J.

Please send me the following bulletins:
☐ New Type "D" Motor Bulletin No. HP-3304
☐ Consolidated Catalog & Price List No. HP-3310

Name_____
Company_____
Street_____
City_____ State_____

INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES

These customers will drive in...

when you have snow melting!

"Not just a convenience but a *distinct competitive advantage!*" . . . that's what merchants are saying about snow and ice removal systems for super markets, shopping centers, service stations, department stores and other commercial establishments selling to the public.

Clean, bare driveways, parking areas and sidewalks (contrasted with snowy, slushy street approaches and *un*cleared competitors' places) become a strong *invitation* for shoppers to "turn in" . . . to do business where they are so obviously wanted. That's not just theory, but *fact*, proved statistically by progressive businesses where steel pipe snow melting systems are at work.

Yes, *steel pipe* is the first choice for these installations. The known economy of steel pipe makes investment in a snow melting system economically practical. And in service, steel pipe has a performance record proved in more than 60 years in hot water and steam heating applications. Add to this the advantages of formability and weldability for coil fabrication and you know why steel pipe is the most widely used pipe in the world . . . for snow melting, heating, plumbing, fire sprinkler systems, power, steam and air transmission.

Send for the free 32 page booklet "Steel Pipe Snow Melting and Ice Removal Systems."

Committee on
STEEL PIPE RESEARCH
AMERICAN IRON AND STEEL INSTITUTE
350 FIFTH AVENUE, NEW YORK 1, N.Y.

Steel Pipe is First Choice

National Biscuit Company
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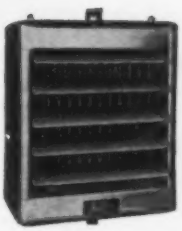
Architect: Alexander D. Crossett, New York, N. Y.
General Contractor: Ragnar Benson, Inc., Chicago, Ill.
Heating Contractor: Robert Gordon, Inc., Chicago, Ill.

Airtherm



90 VERTICAL DISCHARGE HEATERS INSTALLED from 102,500 BTU to 185,000 BTU

92 HORIZONTAL DISCHARGE HEATERS INSTALLED from 14,800 BTU to 250,000 BTU

STEAM UNIT HEATERS

WARM THE WORLD'S LARGEST BAKERY

To achieve flexible, economical heating throughout Nabisco's new $20 million Chicago plant, 182 Airtherm steam unit heaters have been installed. The plant is the world's largest cracker and biscuit bakery with ovens the length of football fields, almost 20 acres of floor space and a capacity of 167 million pounds yearly.

When the area to be heated presents unusual problems, chances are you can solve them easily and economically with the flexibility of Airtherm unit heaters.

Convectors | Vertical Steam Unit Heaters | Horizontal Steam Unit Heaters

Centrifugal Fan Type Unit Heaters | Direct Fired Space Heaters | Gas Fired Unit Heaters

FOR HEATING SATISFACTION . . . THINK FIRST OF

Airtherm

MANUFACTURING COMPANY

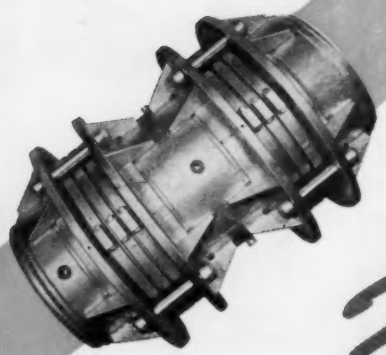
700 South Spring Avenue • St. Louis 10, Missouri

LOOKING FOR AN "ALL PURPOSE" EXPANSION JOINT?

Zallea has never built one—never will. And for good reason. Like all precision engineered equipment, Zallea Expansion Joints are designed to fill specific rigid requirements. In every case, types, sizes and materials of construction are determined by factors of temperature, pressure, traverse and special service conditions.

Zallea Brothers design and build expansion joints for every requirement of modern industry. Field tests have proved the value of our emphasis on designing the expansion joint to fit the problem. Records show that Zallea Expansion Joints outlast all other packless expansion joints from 90% to as much as 1200%. Such reliability is further proof of Zallea design superiority.

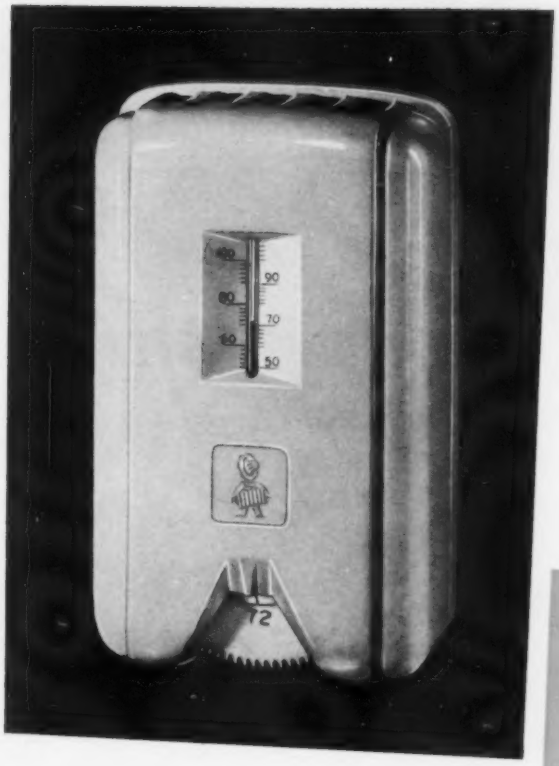
Zallea representatives are always ready to help solve problems relating to expansion joints. Or if you prefer, write for Bulletin 351 which describes the many standard types available.



Zallea expansion joints

ZALLEA BROTHERS, 816 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints



This new Fulton Sylphon Room Thermostat, No. 801 Series, operates within plus or minus ½° of set point. The compact, sturdy design employs a powerful Sylphon Bellows thermostatic unit to provide accurate response to the slightest change in room temperature.

Cable or blanket type panels, wall heaters, suspended unit heaters and portable heaters are accurately controlled by this heavy duty, line voltage type unit. The No. 801 Thermostat can be used also for direct line voltage control of stokers, oil burners and circulating pumps. Use the convenient coupon for complete details.

NEW ROOM No. 801 THERMOSTAT

• For Electric Heating Units • Small As A Switch Plate And Extends Out Only 1⅞" • Rating: 20 amps. (non-inductive load) at 125-250 V.A.C.; ¾ HP at 115 V.A.C. and 1½ HP at 230 V.A.C. • Easily Installed • UL Approved

FROM FULTON SYLPHON TEMPERATURE REGULATOR HEADQUARTERS, U.S.A.

Mr. Controls

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION

FULTON SYLPHON DIVISION

Knoxville 1, Tennessee

Please send me a copy of the new Room Thermostat Bulletin 801.

Name_____

Company_____

Address_____

City_____ State_____

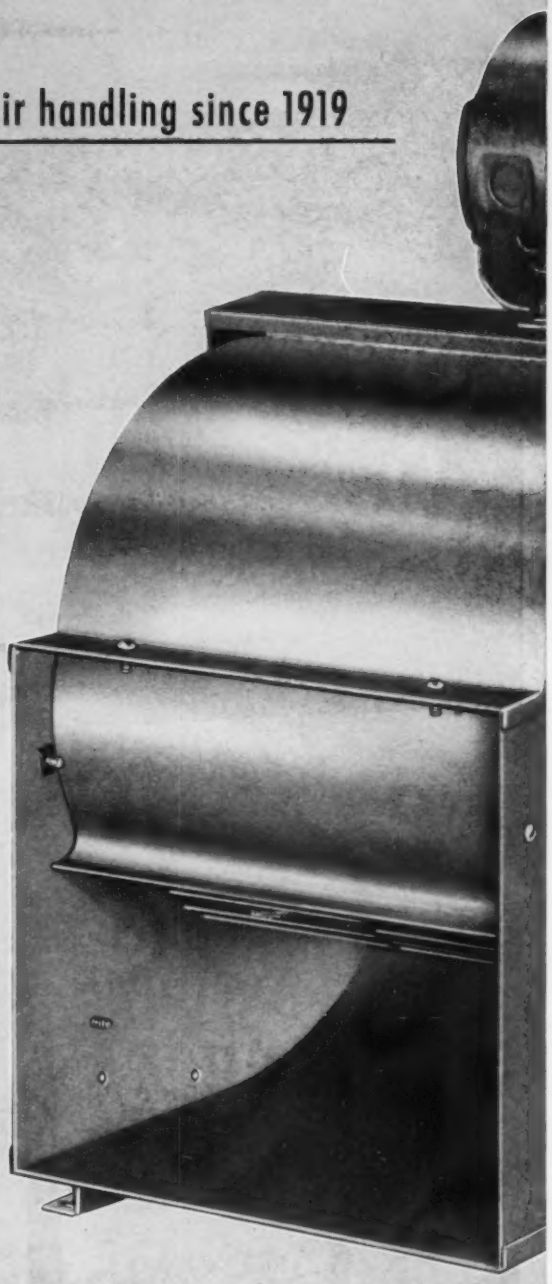
Brundage ...for better air handling since 1919

Quiet Please...

Quiet is the word for Brundage Blowers — and the key to happy customers who don't even want to know they have a blower.

Add the practically service-free performance of extra-strong construction and you have a sure hit with your dealers too.

Whether you manufacture heating or cooling equipment, you can be sure of the quality to match your finest product when you choose Brundage . . . quality proven since 1919.



ASK FOR SAMPLE BLOWERS TO PROVE BRUNDAGE VALUE IN YOUR OWN LAB.

RELIABLE SERVICE— WHEN YOU NEED IT!

WRITE FOR FREE LITERATURE PRICES ON REQUEST

THE **Brundage** COMPANY

512 N. PARK STREET • KALAMAZOO, MICH.

Phone 2-0251

before → after

Modern Dravo heating saves this plant $6732 per year, frees 3400 sq. ft. of floor space

Sharp increases in heating costs traveled hand-in-hand with growth and expansion at Ideal Electric and Manufacturing Company's Mansfield, Ohio plant.

As manufacturing additions went on over the years, more and more hand-fired coal stoves were employed to heat new areas. Until recently, heating for the seven-acre plant area was handled by thirty-two such units. Heating problems never seemed to cease. With the lack of uniformity in heating, workers either froze or baked. Coal and labor costs (it took almost the full time of 5 men to fire stoves around the clock) never stopped climbing. Stoves and their bins gobbled up more than 4000 square feet of plant space!

When modern Dravo gas-fired, forced-air space heaters were installed, these problems disappeared, and the savings were immediate and substantial. Since eleven Dravo "Counterflo" heaters provided comfortable heat everywhere in the plant areas, 3400 square feet of valuable space was released ("Counterflo" heaters required only 600 square feet). But, more important was the actual gross savings of $6732 made possible last winter, '54-'55, through the use of these Dravo Heaters. When amortizing this new and standby equipment over a 10 year period, a net savings of $2735 per year is realized!

Remarkable? Then you will want to see for yourself what unusual cost-savings and heating efficiency Dravo heaters can bring to your heating systems. Use the coupon below to get complete details. You'll find it always pays to investigate Dravo Heaters!

Dravo Corporation, Department A-1408
Fifth & Liberty Avenues
Pittsburgh 22, Pa.

I am interested in Dravo Heaters for _____

☐ Please send literature
☐ Please have representative call

DRAVO
CORPORATION
Pittsburgh 22, Pennsylvania

Representatives in all principal cities

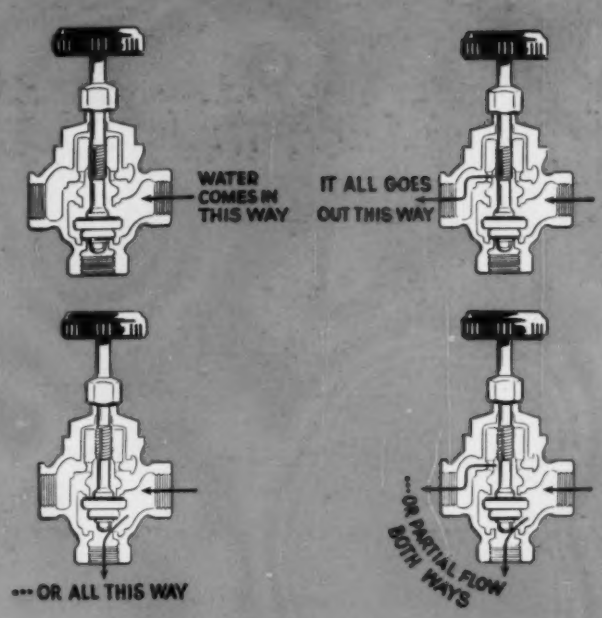
Name _____

Company _____

Address _____

City _____ Zone _____ State _____

O-B Three-Way Valve Works Like This



● Here's a low-cost valve that can be installed on any forced circulation heating or cooling system using remote units. Water flow through the unit can be controlled manually in any of the three ways shown above.

Regardless of the position of the valve, the quantity of water pumped through the system does not change. That means each unit can be adjusted to suit individual preference of temperature range without affecting other units in the system. It means the pump load remains constant, providing protection against pump damage.

The No. 4600 valve is available with threaded pipe ends in $\frac{3}{8}$ or $\frac{1}{2}$-inch sizes. Pipe ends can also be supplied bored to accommodate $\frac{1}{2}$-inch tubing.

Additional information on this new valve is contained in bulletin 1319-V. Write for your free copy.

Ohio Brass

MANSFIELD OHIO, U.S.A.

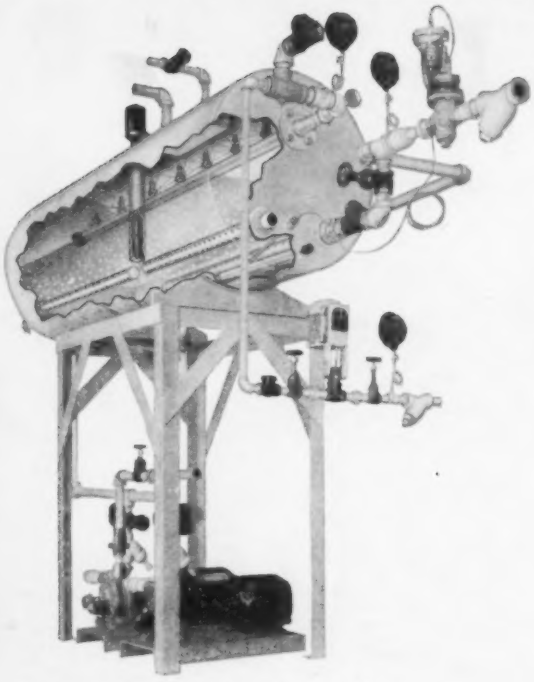
Now

"Budget-Priced" CORROSION PROTECTION

for the Small to Medium Steam Plant

The New

SCHAUB "03" *Deaerator*



- ***Combats "Return Line" Corrosion***
- ***Simpler in Principle***
- ***Gives Positive Oxygen Removal to .03 CC/Liter***

It is in plants of 3,000 to 30,000 lbs/hr boiler capacity — often operating at low pressure — that "return line" corrosion is most apt to rear its ugly head. This happens even when raw water make-up is negligible.

The Schaub .03 Deaerator was designed especially for these plants. It offers an effective and economical way to "clean up" boiler feedwater that will pay for itself many times over. It is equally applicable to high pressure installations.

The *big* difference in the Schaub .03 Deaerator is that it operates fully vented at *atmospheric* pressure. Noncondensible gases escape *immediately* and *completely*. Premium cost construction is eliminated, maintenance and operating costs are reduced to a minimum. Simple but effective spray-contact vent condensing prevents wasteful steam vapor loss. Pin-point temperature control, "live action" heating, and rust proof Chromasoid lining are exclusive features.

FRED H. SCHAUB ENGINEERING COMPANY

2116 South Marshall Boulevard • Chicago 23, Illinois

Write for Bulletin 1300 — and the full story on this low-cost, more efficient Deaerator.

Simple as it is, there's a lot more to the Schaub .03 Deaerator than can be told on this page. Bulletin 1300 is filled with facts for the operating or consulting engineer responsible for boiler feedwater deaeration. It tells the "hows" and "whys", and the basic differences in the Schaub .03 method. Mail the coupon now. No obligation, of course.

NOTE: The Schaub .03 Deaerator is designed for boilers up to 1,000 HP. or 30,000 lbs. per hour. For capacities up to 100,000 lbs. per hour at .005 cc/liter "zero-oxygen" removal, write for Bulletin 575, describing the Schaub Zero-Oxygen Deaerator.

FRED H. SCHAUB ENGINEERING COMPANY
2116 South Marshall Blvd., Chicago 23, Illinois

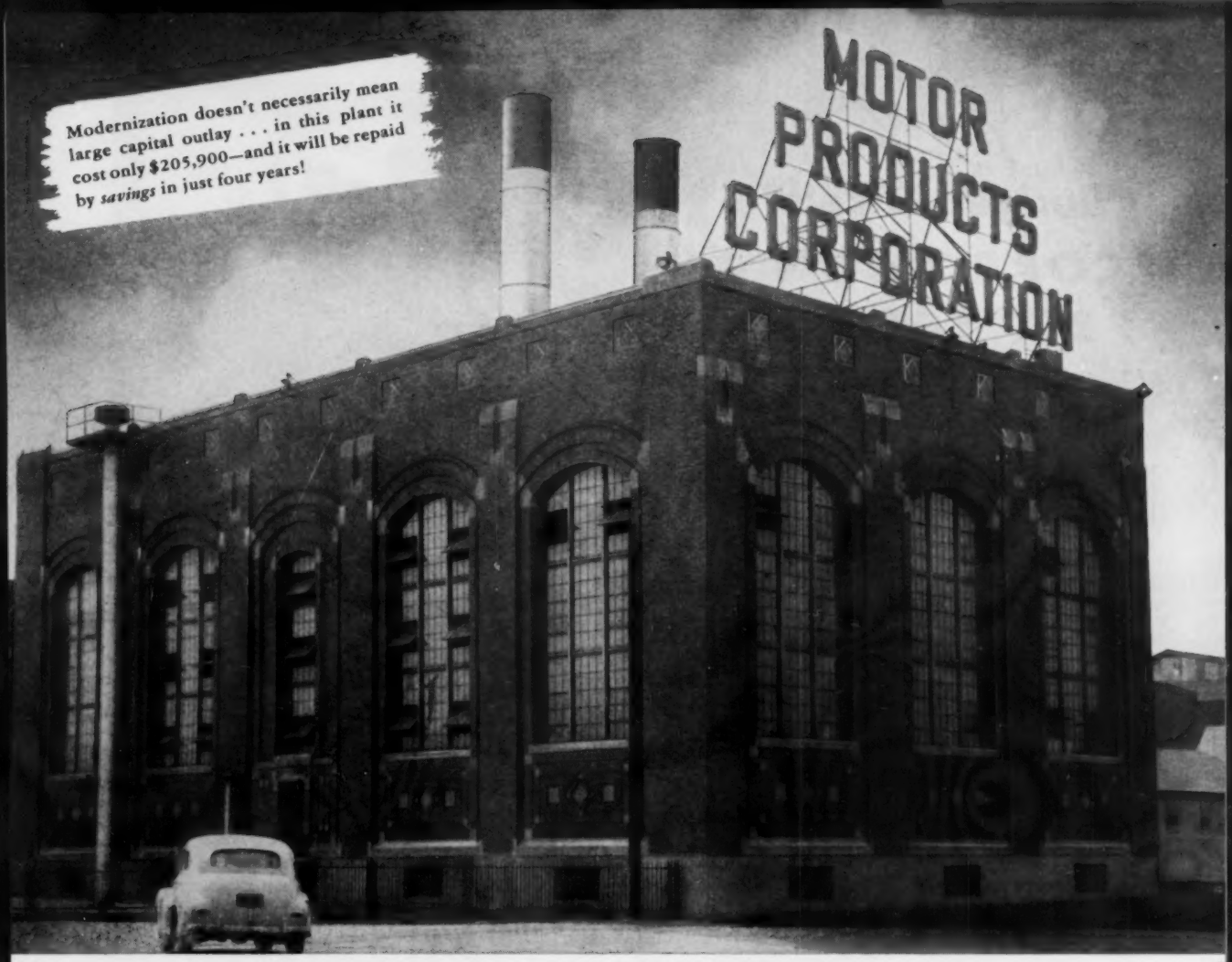
Please send me, without cost or obligation, my personal copy of your new Bulletin 1300 on Boiler Feedwater Deaeration.

Name.....

Company.....

Address.....

City.....Zone....State.....


Modernization doesn't necessarily mean large capital outlay . . . in this plant it cost only $205,900—and it will be repaid by *savings* in just four years!
MOTOR PRODUCTS CORPORATION

Burning coal the modern way saves Motor Products $54,000 a year

Faced with poor boiler control, air pollution difficulties, inefficient coal and ash handling and other costly defects in its outmoded power system, Motor Products Corp., Detroit, called in local consultants to make a study. The engineers recommended a modernization program, involving some new equipment along with the adaption of existing units to new systems.

This modernization is saving Motor Products time, labor, and money—better than $54,000 per year. Now the entire operation is clean and efficient. Production of economical steam is faster, simpler, more reliable and well within the bounds of smoke and dust regulations.

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal, burned the modern way, compares to other fuels. Why not talk to a consulting engineer or your nearest coal distributor? Their advice may save you thousands of dollars each year.

facts you should know about coal

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.

Automatic coal and ash handling systems can result in a virtually labor-free plant.

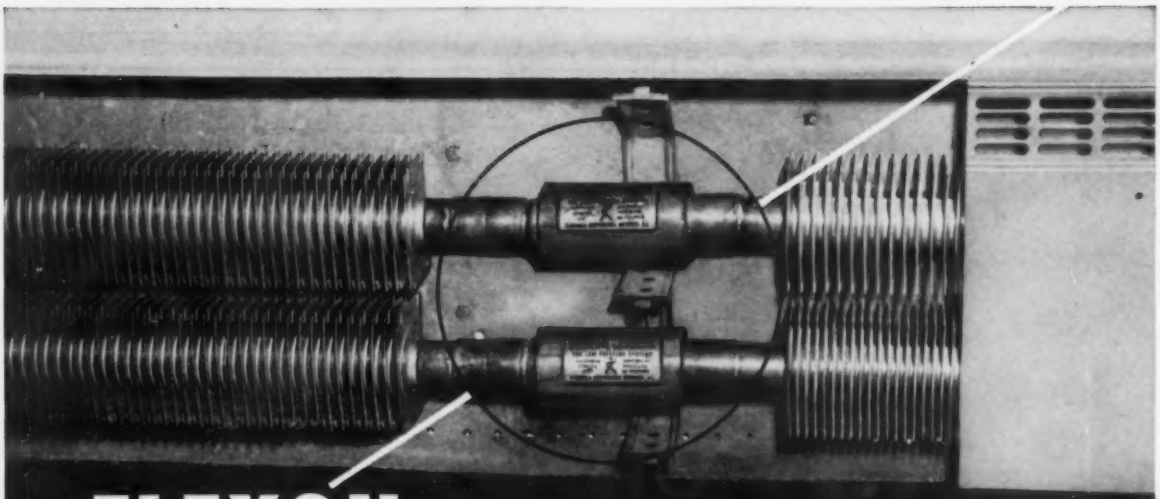
Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.

In most industrial areas, bituminous coal is the lowest-cost fuel available.

Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D.C.



FLEXON EXPANSION COMPENSATORS

the economical solution to Heating System Expansion Problems

For medium
and high pressure piping—
FLEXON EXPANSION JOINTS

FREE FLEXING TYPE—Available in sizes from 3″ through 48″, I.D. in copper or stainless steel. Suitable for pressures from vacuum to 30 psi and temperatures from —20° F. to 850° F. Flanges or welding ends.

CONTROLLED FLEXING TYPE—Available in sizes from 3″ through 24″, I.D. with copper or stainless steel pressure carrier and cast iron control rings. Suitable for pressures from vacuum to 300 psi and temperatures from —20° F. to 850° F. Flanges or welding ends.

SPECIAL TYPES—A variety of assemblies are available for special requirements including special very high pressure units for pressures to 5500 psi. For recommendations send an outline of your requirements.

DESIGN GUIDE—The Flexon Expansion Joint Design Guide is a 24 page handbook on the selection and application of expansion joints. Write for your free copy, today.

■ It's practical, economical and easy to install Flexon Expansion Compensators in steam and hot water system lines. Their use in heating lines puts an end to leakage caused by uncontrolled expansion and minimizes annoying pipe creeping noises. Ideal for home, offices, schools or any other building, just install them and forget them—no maintenance is required!

The FLEXON Expansion Compensator consists of a two ply corrosion resistant bellows with copper tube end connections. The bellows section is enclosed in a floating protective shroud. The unit is designed to handle axial motion up to ½″ and is suitable for temperatures from −60° F. to 300° F., and for pressures up to 40 psig. Sizes are ¾″, 1″ and 1¼″ with copper tube ends as standard (threaded fittings also available). 2″ size is available with threaded fittings only.

Get further information on the use and advantages of FLEXON Expansion Compensators from your Flexonics representative or use the coupon below to get your copy of a descriptive bulletin.

Flexonics *Corporation*

Flexon identifies products of Flexonics Corporation that have served industry for over 53 years.

EXPANSION JOINT DIVISION
1391 S. Third Avenue
Maywood, Illinois

Flexonics Corporation
1391 S. Third Ave.
Maywood, Ill.

Please send me the bulletin which describes and gives full specifications for the Flexon Expansion Compensator.

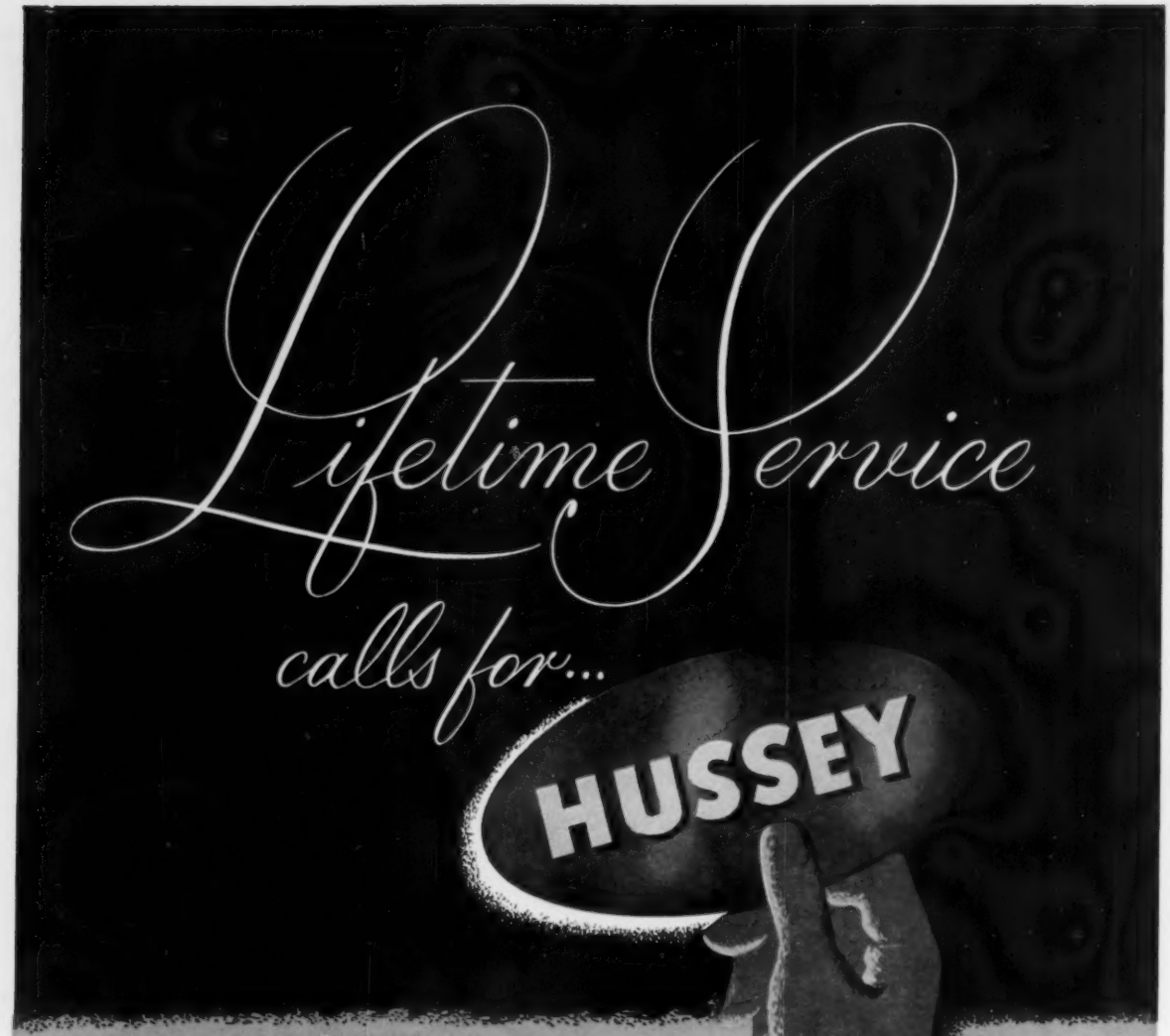
Name .....

Company .....

Address .....

City ..... *Zone* .... *State* .....

My Wholesaler is: .....



COPPER & BRASS

Since 1848

Jobs like yours, where corrosion is accelerated and efficiency is essential both in installation and actual service, call for the finest materials you can use. Hussey Copper offers you peak corrosion resistance, excellent efficiency in thermal conductance and emissivity *plus* uniformity and ease of fabrication that's hard to beat. If you have not been using these advantages of genuine Hussey Copper, figure it into your *next* job. Order Hussey Copper direct from the mill or from your nearest Hussey Copper warehouse.

C. G. HUSSEY & COMPANY
(Division of Copper Range Co.)
Rolling Mills and General Offices: Pittsburgh 19, Pa.

7 Convenient Warehouses to serve you

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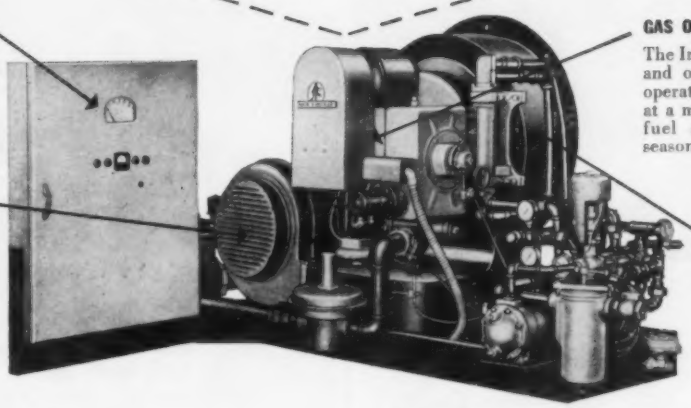
CHICAGO (16), 3900 N. Elston Avenue
PHILADELPHIA (30), 1622 Fairmount Ave.
CINCINNATI (2), 426 Commercial Square
ST. LOUIS (3), 1620 Delmar Boulevard

Modernize your boiler room

with this dual-fuel firing unit

AUTOMATIC CONTROLS
All combustion controls are completely assembled, wired, and tested at the factory. They're fully enclosed in a single control panel for permanent protection from dust and damage.

FORCED DRAFT SYSTEM
This forced draft air supply makes possible automatic modulation over a wide range. It is sealed for positive pressure firing and eliminates need for a high stack. Direct-drive construction and low-speed ball-bearing motor assure long trouble-free life.



GAS OR OIL, OR BOTH
The Iron Fireman combination gas and oil burner allows switch in operation from one fuel to another at a moment's notice. Overcomes fuel shortage problems; gives seasonal price advantages.

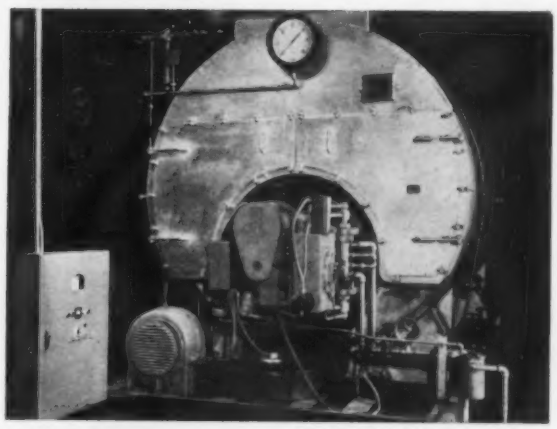
BUILT-IN REFRACTORY
The combustion throat, with built-in refractory, is an integral part of burner assembly. Eliminates on-the-job brickwork.

More than a burner— a complete *PACKAGE* firing system . . .

Iron Fireman package units are much more than conversion burners. They are *complete combustion systems*—with integrated burner (for gas or oil, or both), fuel control system, forced draft air supply, automatic controls, and pre-formed refractory combustion throat.

These firing units are adaptable to practically every type of boiler. Installation consists of little more than attachment to the boiler front, and making electrical and fuel connections. Consequently, installation time costs are sharply reduced from those of any comparable system, assembled in the field.

The Iron Fireman package plan factory-assembles all component parts. It eliminates the divided responsibility of assorted local contracts. And it brings long-range fuel and operating savings, which explain why more and more plants—like that of the Menasha Woodenware Corp. shown here—are switching to Iron Fireman package units.



Menasha Woodenware Corp., Rockford, Ill., reports their Iron Fireman package unit has lowered fuel costs 6.6% during its first year, with steadier firing and greater cleanliness. Package units are available in a complete range of sizes, as well as the boiler-burner combination shown here. Installation by Allied Heating Engineers, Rockford, Illinois.

It will pay you to get full information on Iron Fireman package burners and boiler-burner units. Just mail the coupon or write.

Iron Fireman®

AUTOMATIC FIRING EQUIPMENT FOR OIL, GAS, COAL HEATING, PROCESSING, POWER

Send for full information . . .

IRON FIREMAN MANUFACTURING CO.
3062 W. 106th Street, Cleveland 11, Ohio.
In Canada, 80 Ward Street, Toronto, Ontario.
Send information on Iron Fireman package burners.

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Address_____

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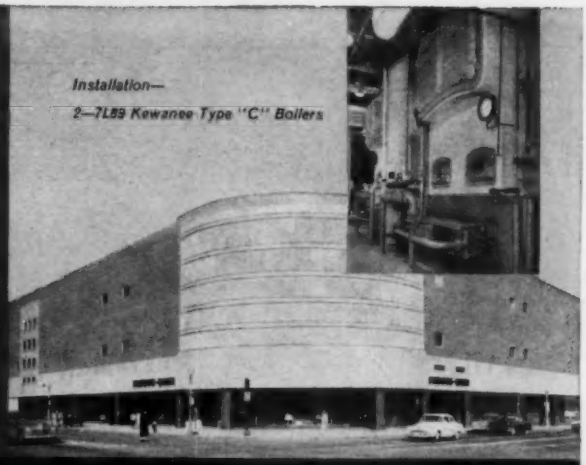
"Operating-Maintenance Costs Cut with Kewanee Boilers"

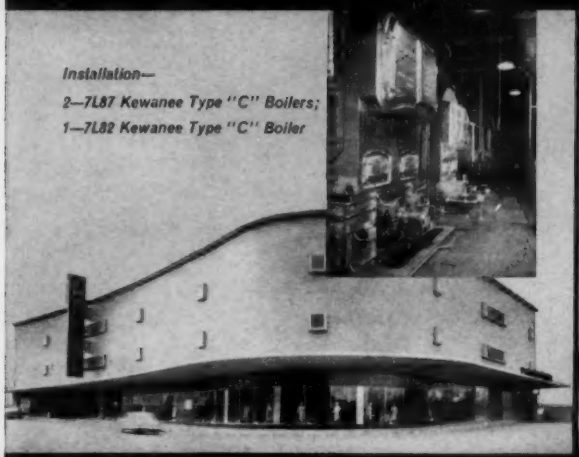
Noel Spannagel, Chief Engineer, Famous-Barr Company



Installation—
2—7L89 Kewanee Type "C" Boilers

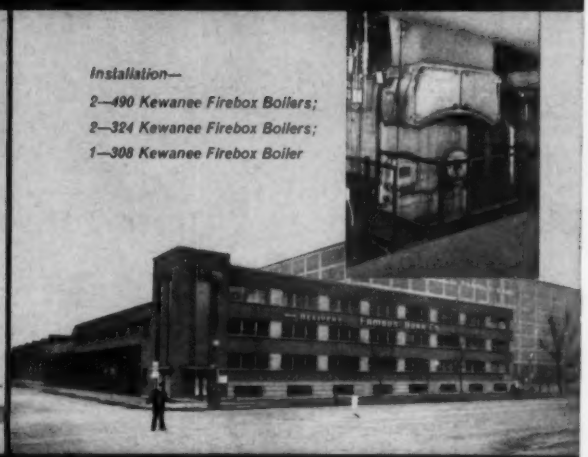
Here are 3 installations of Kewanee Boilers at Famous-Barr Company

Heating Contractor: Eichler Company; Architect: P. J. Hoener; Engineer: John D. Falvey



Installation—
2—7L87 Kewanee Type "C" Boilers;
1—7L82 Kewanee Type "C" Boiler

Heating Contractor: Eichler Company; Architect: Russell Mullgardt Schwarz Van Hoefen; Engineer: John D. Falvey



Installation—
2—490 Kewanee Firebox Boilers;
2—324 Kewanee Firebox Boilers;
1—308 Kewanee Firebox Boiler

Heating Contractor: Eichler Company; Architect: Will Levy

KEWANEE reserve plus rated boilers

...PREFERRED BY FAMOUS-BARR FOR OVER 1/4 CENTURY

Back in 1928 the Famous-Barr Company, St. Louis, installed 2 Kewanee Stoker Fired Boilers in a warehouse . . . so began an experience with Kewanee Boilers that has extended over the past quarter century. As they expanded, as new buildings called for more power, Kewanee was the preferred boiler installation every time. But let Noel Spannagel, Famous-Barr's chief engineer, tell the story:

"My previous experience proved Kewanee offered important savings in operating and maintenance as compared with other boilers." Famous-Barr long has known the advantages assured by Kewanee Reserve Plus Rated Boilers such as provision for expansion—"cruising speed" operation which lowers operating and maintenance costs and lengthens boiler life. So when you consider boilers, be sure they are rated on nominal capacity to operate at "cruising speed."

Don't be misled by promises that a boiler delivers steam to meet average daily requirements. Only a boiler rated on nominal capacity can guarantee performance beyond the call of usual duty.

KEWANEE BOILERS

KEWANEE-ROSS CORPORATION, Kewanee, Illinois
Division of American Radiator & Standard Sanitary Corporation
Serving home and industry - American Standard - American Blower
Church Seats & Wall Tile - Detroit Controls - Kewanee Boilers
Ross Exchangers - Sunbeam Air Conditioners

YOU can depend on KEWANEE engineering

MECHANICAL CONSULTANT: KARSUNSKY, WELLER & GOOCH CO.

Holy Redeemer School Installs and Insulates 115-Foot Steam Line with Gilsulate® in 24 Man-Hours

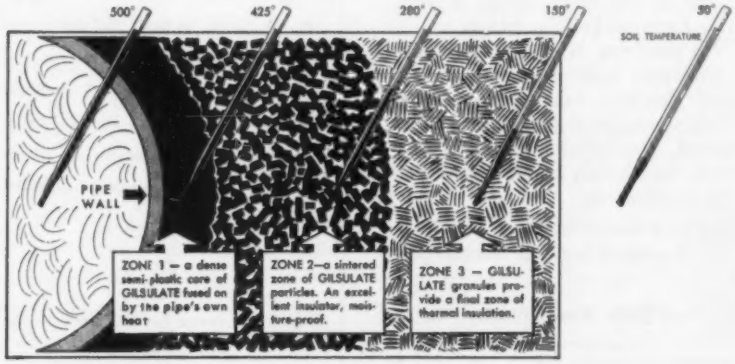
LOW-COST INSTALLATION HAS LIFETIME PROTECTION AGAINST HEAT LOSS AND CORROSION

Here's more proof that GILSULATE can save money for *you*—even on *small* as well as large jobs.

The Holy Redeemer School, Washington, D. C., recently installed 115 feet of 5-inch and 1¼-inch pipe for steam lines and return into their new 16-classroom building. Only 3 men were employed on the job. The installation was made in a trench 6 feet deep. The GILSULATE, after being wheeled to the top of the ditch, was skidded down and poured into forms around the pipes.

Total time for the *complete* job—including form construction, pouring 6½ tons of GILSULATE, and backfilling—was 24 man-hours. No other method for insulating and protecting hot underground pipes can match this performance—*Triple-Zone* GILSULATE *shows the lowest installed cost providing efficiency and permanence.*

Investigate the value of this easily installed, low-cost GILSULATE. Use the coupon below for complete information, or see your local GILSULATE distributor.


500°
425°
280°
150°
90°
SOIL TEMPERATURE
PIPE WALL
ZONE 1 — a dense semi-plastic core of GILSULATE fused on by the pipe's own heat
ZONE 2—a sintered zone of GILSULATE particles. An excellent insulator, moisture-proof.
ZONE 3 — GILSULATE granules provide a final zone of thermal insulation.

Facts about Gilsulate

1. *Easy to use*—just pour, tamp and backfill...pipe heat does the rest.
2. *Forms 3 zones* of protection against heat loss and all hazards commonly encountered by hot buried pipes.
3. *Needs no housing or mechanical sheaths:* no mixing, special handling or equipment.
4. *Only needs normal pipe spacing:* for multiple pipe or cramped conditions.
5. *Three types available:*
   Type A for 220°-310° F. temp. range
   Type B for 300°-385° F. temp. range
   Type C for 385°-520° F. temp. range

THE TRIPLE-ZONE INSULATION FOR LIFETIME PROTECTION OF HOT UNDERGROUND PIPES

GILSULATE®

AMERICAN GILSONITE COMPANY, SALT LAKE CITY 1, UTAH
Affiliate of Barber Oil Corp. & Standard Oil Co. of California

American Gilsonite Co.
134-B West Broadway, Salt Lake City 1, Utah — or — 1145 East Jersey St., Elizabeth, N. J.

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COMPANY .....

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HPA

P.S. In the Summertime with the steam off, the revolving discharge outlets produce a pleasant cooling effect . . .

The fact that the discharge outlets of the Wing Revolving Heater keep the heated air in constant gentle motion, with no steady sickening blasts of hot air on the workers, is one reason why so many firms are adopting Wing Revolving Heaters as "morale boosters". Employees in these plants work in pleasant, comfortably warmed surroundings, and being comfortable they are more productive.

Shouldn't *you* learn more about Wing Revolving Heaters? Just use the coupon.

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Factories: Linden, N. J. & Montreal, Can.
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Please send me Bulletin HR-6A-Revolving Heaters

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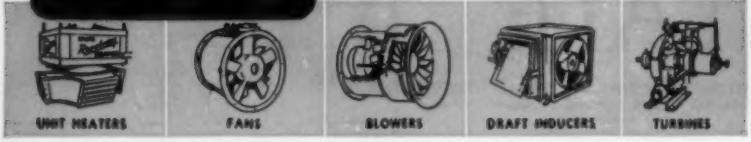
Firm.....
Address.....
City.....Zone.....State.....



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"Correct Practice in Industrial Piping"

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This practical book is made up of outstanding papers and data on industrial piping selected from past issues of "Heating, Piping & Air Conditioning." It is a most comprehensive collection of case studies, showing how various difficult piping problems encountered in different industrial plants were successfully worked out by piping experts.

Design, installation, operation, and maintenance . . . steam, air, gas, oil, process, water and refrigeration piping . . . piping in pulp and paper and steel mills, in automobile plants and breweries, in the food and chemical and textile industries, and in many other types of manufacturing plants are dealt with from many different angles.

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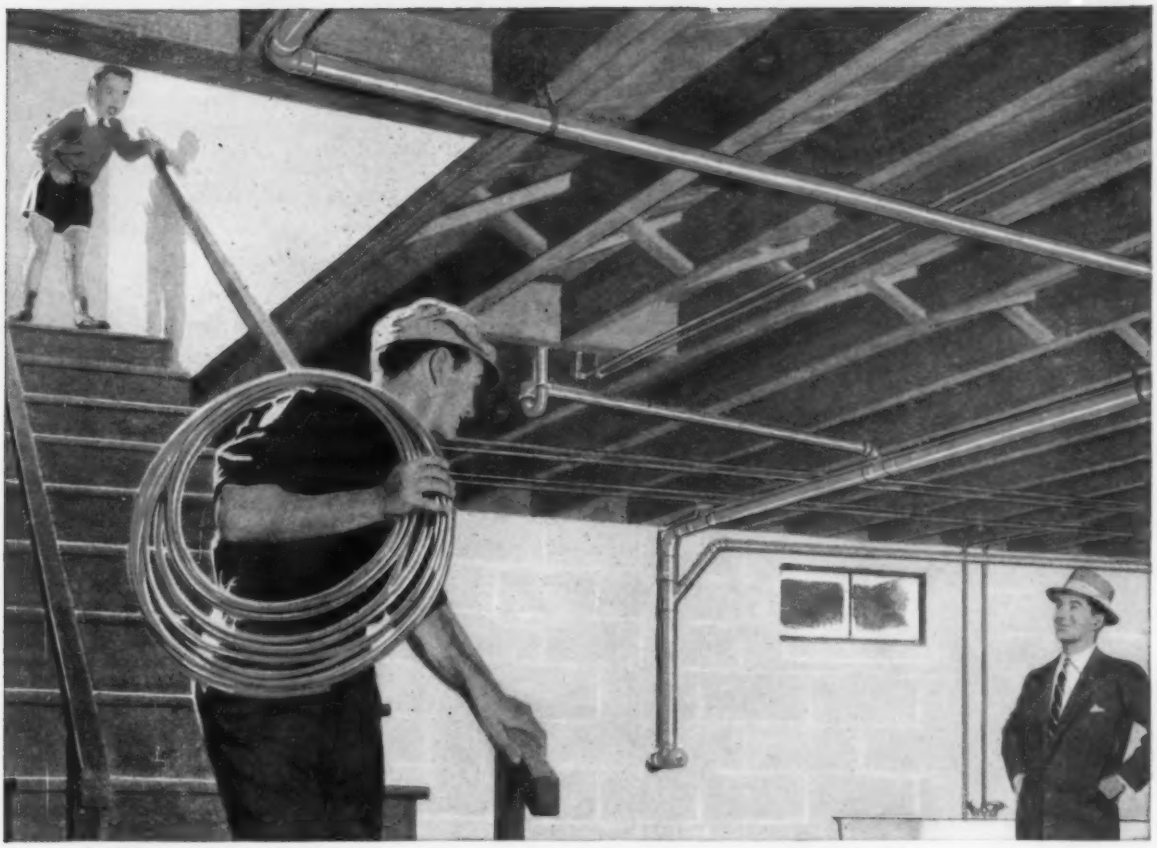

The best cellars feature Chase® Copper Tube

Cellar to attic—all through the house—you cut installation time of water lines when you use Chase copper water tube!

Rugged Chase copper tube is lightweight, easier to handle. Cut it to required length quickly, right on the job. Make leakproof solder joints without time-consuming threading—*fewer* joints, because Chase copper tube comes in 20 foot lengths.

At the same time, you assure customer satisfaction with lines that give *more* years of trouble-free service! Chase copper tube *resists* corrosion—can't clog with rust. Its smoother inside surface cuts friction to a minimum and assures a fast and efficient discharge of fixtures.

Add *extra-quality* to every job at *little or no extra cost!* Install hot and cold water lines of Chase copper water tube. Your Chase wholesaler has full stocks on hand.

Chase copper drainage lines, too, give superior service over the years... add extra-value to any home!

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NO Reducing Valve Needed

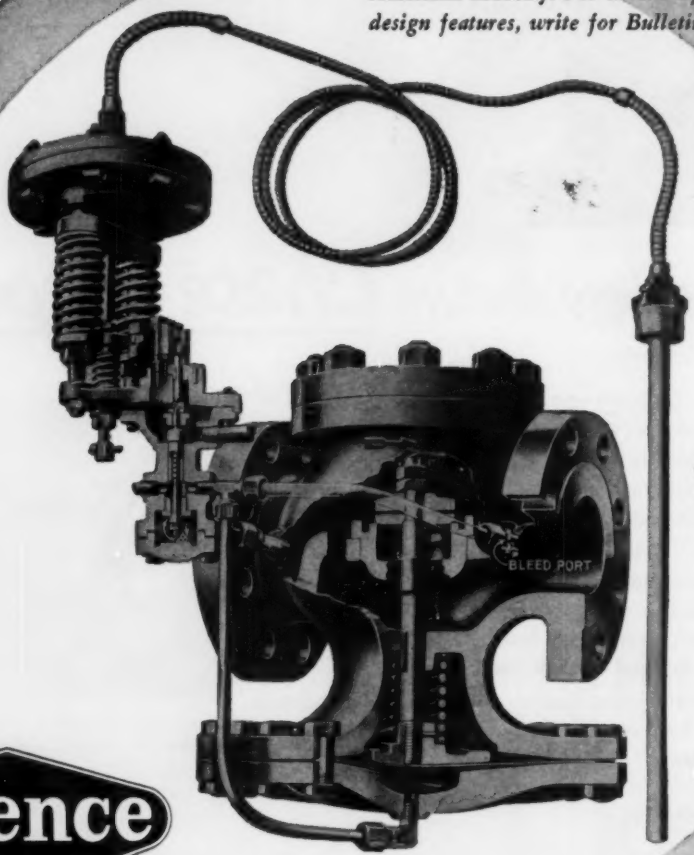
Here's real economy in temperature control.

Because Spence Temperature Regulators are designed to limit heater steam pressures to an adjustable maximum, the need for a separate reducing valve is completely eliminated.

The Spence Regulator takes steam directly from the boiler or high pressure line, reduces the pressure and regulates the flow as required to maintain a constant temperature output from the heater.

This means one relatively small combination pressure and temperature regulator replaces a reducing valve of the same size and a larger temperature regulator. Practically the entire cost of the large separate temperature regulator is saved. And, the total saving would also include the cost of a 3-valve by-pass along with all labor for installation.

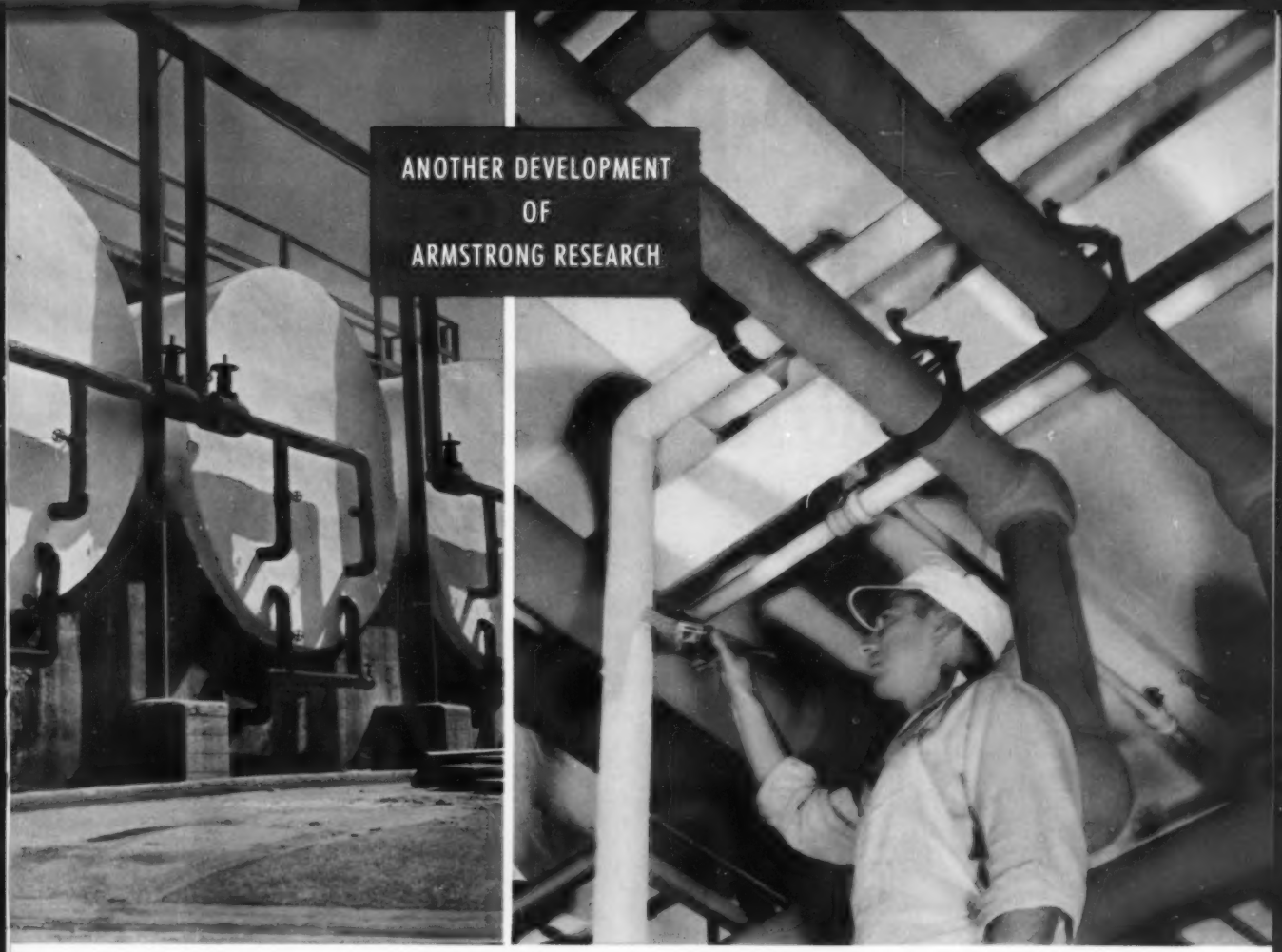
This design feature is just one of the reasons for the thousands of Spence installations throughout American industry. *For details of other important design features, write for Bulletin T50.*



SPENCE
TYPE ET150
Temperature
Regulator

Spence

SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK



Insulcolor . . . *tough plastic finish protects and color codes insulated lines and tanks*

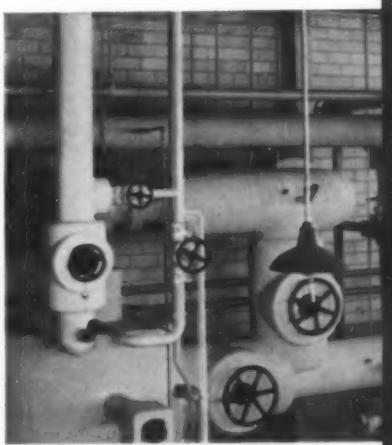
On both indoor and outdoor installations, you can be sure of long-lasting protection with this rugged insulation finish. And the durable plastic Insulcolor® coating not only protects insulated lines, tanks, vessels, ducts, and cold rooms, but serves as color identification, too.

Available in a choice of seven colors and white, Insulcolor furnishes a smooth, good-looking finish. It will withstand a wide range of temperatures and severe outdoor conditions without cracking, crazing, or peeling. Bumping or abrasion will not damage Insulcolor's tough plastic surface, and Armstrong Insulcolor is both fire resistant and moisture resistant, too.

Insulcolor is quickly and easily applied by brush or spray gun. An application lasts many years with little or no maintenance. Dirt, grease, and soot are readily washed off the smooth Insulcolor surface.

One of many products developed by Armstrong Research for the industrial insulation field, Insulcolor is readily available through the Armstrong Contract Service. Get full details on Insulcolor and the Armstrong Contract Service from your nearest Armstrong office. For your copy of the free 32-page booklet, "Armstrong Industrial Insulations," write today to Armstrong Cork Company, 209 Stratton Street, Lancaster, Pennsylvania.

Armstrong INDUSTRIAL INSULATIONS



Because Insulcolor color codes, as well as protects, it eliminates the bother and expense of stenciling or painting insulated lines with an identifying color after the finish has been applied.

Carrier absorption refrigeration

that cools water with steam

Now with *AUTOMATIC* STOP and GO

100 to 700-ton Capacity

NO OTHER REFRIGERATION MACHINE HAS ALL THESE FEATURES:

Cools water with steam. Low-pressure steam from idle or excess boiler capacity or from central or district mains can be used for cooling at great savings.

Quiet operation—no major moving parts. Small circulating pumps are the only moving parts so that the machine operates without vibration and at extremely low sound level.

No damage from overloads. Inherent nature of the absorption machine is such that it cannot be damaged from improper operation or overloading. Sudden or continuous overloads will merely cause the chilled water temperature to rise.

Complete range of load variation. The only refrigeration equipment that operates efficiently from full load down to zero capacity in a completely automatic cycle with perfectly smooth operating curve.

Flexible and economical installation. Installation is simple and economical in any part of a building. Lighter weight, vibrationless operation and compact size permit location anywhere space and steam are available, from roof to basement.

Completely safe. Machine operates under vacuum, with water as the refrigerant and a simple salt as the absorbent. Nothing could be safer.

Operates by TIME CLOCK THERMOSTAT or PUSH BUTTON

Can you imagine starting up a big 700-ton refrigerating machine without turning any valves or throwing any switches? That's exactly what you can do with this new automatic Carrier Absorption Machine.

The simplest of all refrigerating machines is now completely automatic. All the complexities of start-up and shut-down have been made so simple that a tiny push button, a thermostat or a time clock will control the machine's operation.

Only Carrier makes large absorption refrigerating machines. They cool water with steam. They are efficient, quiet and reliable. And now—with automatic STOP and GO—they are the easiest of all machines to operate.

Eleven standard sizes: You choose the size that fits your needs. Capacities range from 100 to 700 tons of cooling.

WRITE FOR FREE 36-PAGE CATALOG

Find out all the advantages of Carrier absorption refrigeration. Colorful, illustrated booklet includes facts, figures and comments from present users. For your copy, call your nearest Carrier office. Or mail the coupon direct to Carrier Corporation, Syracuse, New York.

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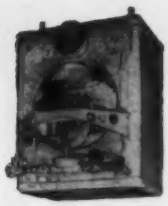
There's a **Reznor** Gas Heater for Every Engineered Heating Job

Gas Unit Heaters

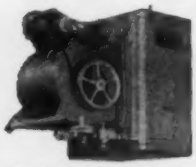
self-contained, completely automatic units for production and distribution of heat at the point of need.

Wherever you go you'll find Reznor heaters proving their versatility in all types of commercial, institutional and industrial buildings from tiny shops to huge factories and warehouses.

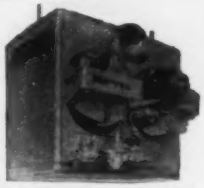
There are two reasons why nearly 50% of the gas unit heaters sold today are made by Reznor — engineering leadership and fine construction. Both have been Reznor traditions since the first Reznor heaters were made, in 1888. An aggressive research and production development program has kept Reznor ahead of the field with improvements for greater comfort or more heat per fuel and equipment dollar. And Reznor's high standards of workmanship and materials mean greater efficiency and longer life.



Propeller Fan Type Suspended Units—nine sizes; 25,000 to 250,000 BTU.



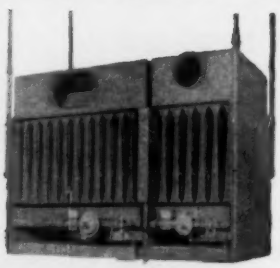
Blower Type Suspended Units—for use where quiet operation is a must — eight sizes; 25,000 to 200,000 BTU.



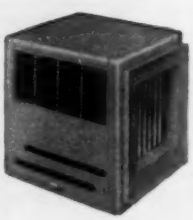
The New Reznor Twin Fan 250,000 BTU Model — another first for Reznor engineering.

Console-Styled Floor Models—for offices, stores and homes—three sizes; 25, 50 and 75 thousand BTU.

Two NEW Duct Furnaces



SERIES DS — Systems with capacities in excess of two million BTU can be assembled, on the job, out of the four basic DS sections. Section capacities are 150, 200, 250 and 300 thousand BTU. The largest single section weighs only 315 pounds. Each section complete with combustion controls and built-in-draft diverter



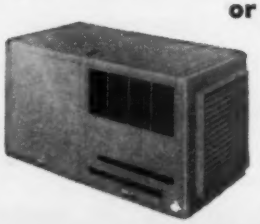
SERIES D — Four sizes; 50, 75, 100 and 125 thousand BTU — compact, handsomely-styled units are complete with combustion controls and built-in draft diverter

for use in custom engineered heating and air conditioning systems

These two new models, though varying greatly in details of design and construction, have the same advantages of high efficiency and easy installation as an integral part of the duct system. And both offer complete flexibility for combination with components for air-moving, cooling, cleaning and humidification chosen to meet the exact requirements of each job.

The Reznor PAC

compact horizontal furnace or deluxe unit heater



Compact design and appliance styling make the PAC ideal for crawl space and attic applications in residential heating or for suspended installations in basement, utility room or kitchen.

Used without ducts, the PAC becomes a deluxe unit heater which meets the most exacting requirements for cleanliness, quiet operation and fine styling.

REZNOR
THE WORLD'S LARGEST SELLING GAS UNIT **HEATERS**

Reznor Manufacturing Co.
51 Union Street, Mercer, Pa.

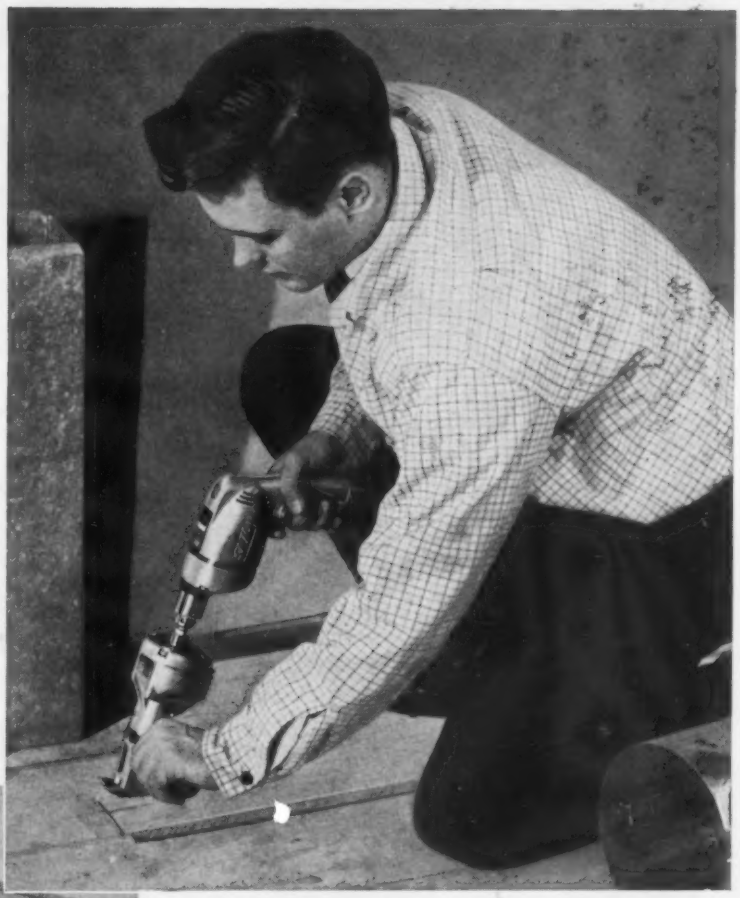
SPEED HEATING INSTALLATIONS!

Do All Your Drilling and Hacksaw Work with the Same SKIL Tool!

Faster, easier cutting! This powerful lightweight drill lets a workman handle the toughest, hard-to-reach jobs with big saving.

Use the Model 75 SKIL Drill for drilling—and in time add the Model 119 Hacksaw attachment where there's sawing. Two tools for one low price!

Model 75 SKIL Drill with Model 119 Hacksaw Attachment



JUST LOOK AT THESE MODEL 75 DRILL FEATURES

- **55% more powerful, yet lighter in weight.**
- **Choice of 7 speeds (2500 and 3500 rpm). Ideal for hacksaw.**
- **Quick conversion to hacksaw duty.**
- **Capacity of ¼" in steel, ½" in wood.**
- **All anti-friction bearings for longer life.**
- **Large inspection plate permits easy cleaning.**
- **And many other design and handling improvements.**

SKIL PORTABLE TOOLS

Made only by SKIL Corporation formerly SKILSAW, Inc.
5033 Elston Avenue, Chicago 30, Illinois
3601 Dundas Street West, Toronto 9, Ontario
Factory Branches in All Leading Cities

FREE! Send this coupon. Your SKIL Distributor will give you a no-obligation demonstration. See how you can increase performance with Model 75 SKIL Drill and Model 119 Hacksaw attachment.

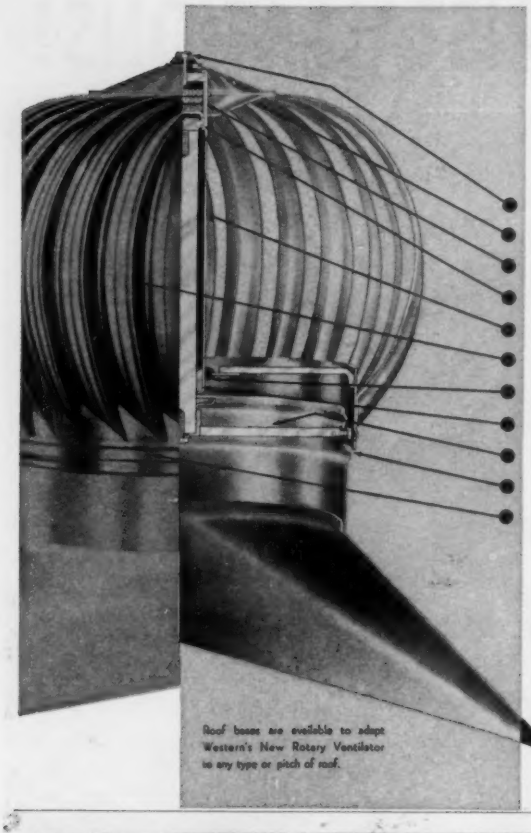
SKIL Corporation, Dept. HPA-85
5033 North Elston Avenue, Chicago 30, Illinois

☐ I would like a demonstration and FREE trial.
☐ Please send literature on SKIL Drill and Hacksaw.

Name_____

Address_____

City_____ Zone____ State_____



Roof bases are available to adapt Western's New Rotary Ventilator to any type or pitch of roof.

NEW- INSIDE AND OUT

WEMCO'S newly engineered roof ventilator is not only strikingly new in appearance, but look inside, and there too, you will see that Western's Rotary is the newest and best answer to ventilating problems!

LOCKED-ON ROTOR prevents loss or damage in the highest winds, yet the ventilator is easy to disassemble without special tools.
BOX-GIRDER CONSTRUCTION is used for rigidity and permanent alignment.

WOOL-PACKED LUBRICANT RESERVOIR is oversized to ensure years of operation with minimum maintenance, under most severe conditions.
PATENTED* BEARING SUSPENSION — New radial thrust ball-bearing keeps friction loading so low that momentum keeps the head spinning even in sporadic winds.
PERMANENTLY SEALED WEATHERPROOF CASING protects upper and lower bearings from airborne dust and grit.
EXCLUSIVE CORRUGATED VANE DESIGN ensures rigidity, and prevents shipping damage.
SIX RUBBER MOUNTINGS completely isolate head from throat — no noise or vibration can be transmitted.
SINTERED BRONZE RADIAL BEARING is oil-impregnated for minimum friction drag and long operating life.
NEW SUPPORT SPIDER ASSEMBLY—redesigned for greater strength and rigidity.

MINIMUM CLEARANCE BETWEEN BASE AND ROTOR prevents backdrafts or air spillage.
BAKED ENAMEL FINISH in soft sea-green hammertone—blends with any exterior, modern or traditional.

* PENDING

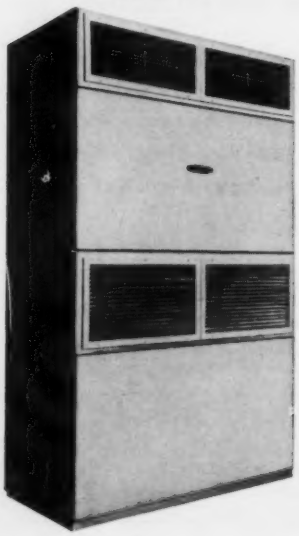
WESTERN ENGINEERING AND MFG. CO. IS THE ONLY MANUFACTURER OF ROTARY VENTILATORS WHO BACKS UP THEIR PRODUCT WITH AN UNCONDITIONAL GUARANTEE. FOR FURTHER INFORMATION ABOUT THIS EXCLUSIVE GUARANTEE, OR FOR THE NAME OF YOUR LOCAL REPRESENTATIVE, WRITE TO:

WESTERN ENGINEERING & MFG. CO.

4116 Ocean Park Ave., Venice, Calif.

HAVE YOU SENT FOR YOUR FREE VENTILATION NOMOGRAM?

Industrial Plants | Stores | Restaurants | Offices



7½-Hp. Frick Unit Conditioner

They All Like

FRICK

Unit Air Conditioners

Built in sizes of 3, 5 and 7½ hp., these Unit Conditioners have the extra cooling capacity, the greater dependability, the superior quietness and economy that discriminating buyers want. Get literature and full information now: join those who, since 1938, have found Frick Unit Air Conditioners the answer to their needs. Write

DEPENDABLE REFRIGERATION SINCE 1882

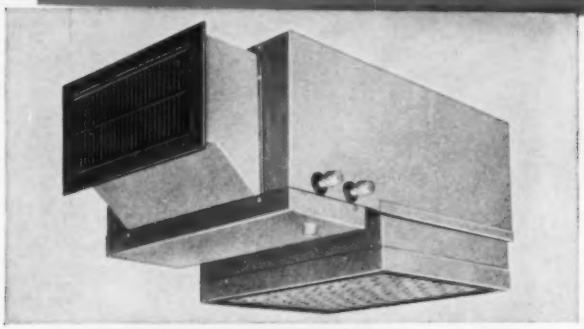
FRICK CO.

WAYNESBORO, PENNA. U.S.A.

Don't do anything until you investigate this

New Air Conditioner

FOR MOTELS, HOTELS, RESIDENCES, OFFICES

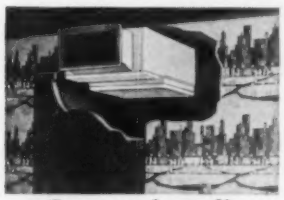


Cools • Heats • Dehumidifies • Filters

Available for direct expansion systems or chilled and hot water systems. Ideal for multiple installations. Each unit individually controlled for personalized comfort.

RECOLD *Model RE*

It's Quiet



Easy to Install

Fits almost anywhere with minimum effort. No ducts. No sheet metal work. Unit is completely enclosed.

Easy to Service

Anyone can remove or replace the filter or the plug-in motor unit in seconds without tools.

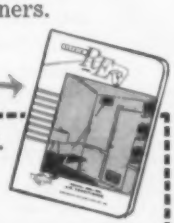
No Buzzing ***No Drumming*** ***No Whistling***

Inexpensive, Efficient, Versatile

RECOLD *RE* solves room air conditioning problems quickly, efficiently, inexpensively. Priced far below comparative units. Saves on installation, too. Comes complete, including electrical connection box. Easily installed almost anywhere in new or existing buildings. Fits into unused area such as space above closet shelf. Outlet fits between studs. RECOLD *RE* gives you three big advantages: low first cost, low installation cost, low maintenance cost.

Specify RECOLD *RE* Air Conditioners.

Write for illustrated folder



Recold

Refrigeration Engineering, Inc.
7250 East Slauson Avenue
Los Angeles 22, California

REFRIGERATION ENGINEERING, INC.
Dept. H-1
7250 East Slauson Avenue
Los Angeles 22, California

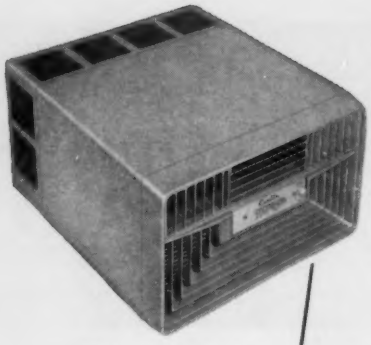
Please send illustrated folder on the Recold RE *Air Conditioner.*

NAME_____

FIRM_____

ADDRESS_____

(or attach to your letterhead)



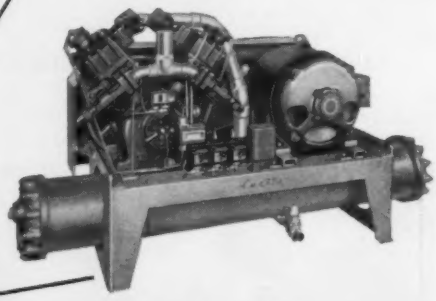
Window Air Conditioners

Packaged Air Conditioning units—2 to 20 tons

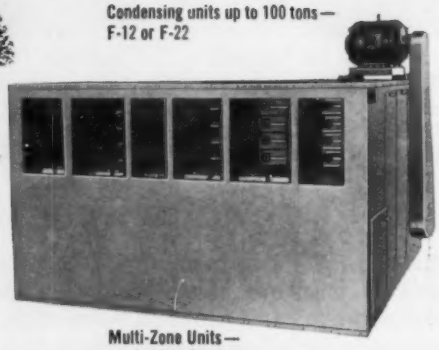
More jobs... More profit!

WITH THIS

complete Curtis LINE

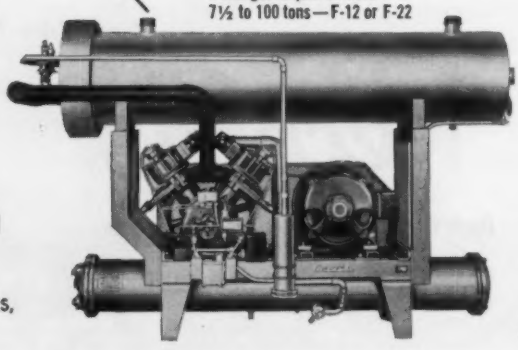


Condensing units up to 100 tons—F-12 or F-22



Multi-Zone Units—serving 2 to 8 zones

Packaged Liquid Chillers—7½ to 100 tons—F-12 or F-22



You'll sell more jobs, and make more profit, with this well-rounded Curtis line. Curtis equipment sells readily because it is backed by one of the oldest and most respected names in the business. Curtis products are presold for you by hard-hitting national advertising in *Saturday Evening Post, Time and Newsweek*, plus many national business and trade magazines.

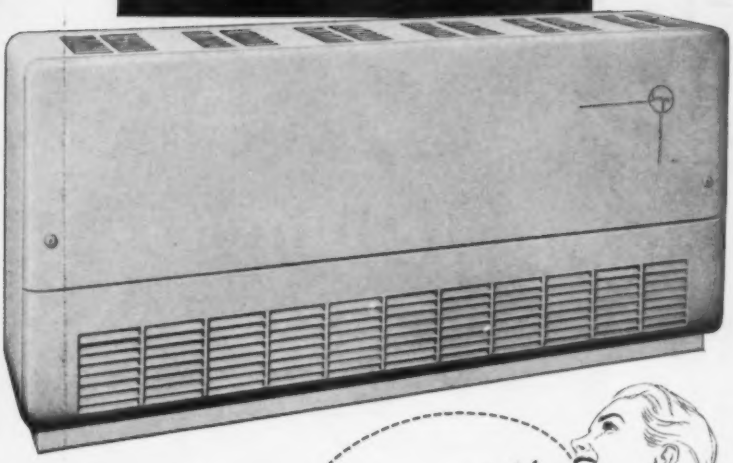
WRITE TODAY for information on how you can obtain a Curtis direct factory franchise.

Curtis REFRIGERATING MACHINE DIVISION
of Curtis Manufacturing Company
1950 Kienlen Avenue, St. Louis 20, Missouri

Other Curtis Products: INDUSTRIAL AND AUTOMOTIVE AIR COMPRESSORS, AUTO LIFTS, CAR WASHERS, AIR HOISTS

829

HERMAN NELSON
console heater



Now choose from 16 models... 64 air inlet-outlet arrangements!

When you apply the Herman Nelson Console Heater to your heating jobs, you apply not one or two choices but *16 different models*—giving you a total of *64 inlet-outlet combinations!* Mount these Herman Nelson units on floor, wall, ceiling or inverted . . . order them for fully recessed, semi-recessed or free-standing applications—and get the unit that *fits your requirements exactly*. Styled with outstanding beauty, Herman Nelson Console Heaters operate quietly, give positive heat distribution, and utilize either steam or hot water. Get complete information now . . . use coupon below.

FLOOR INSTALLATION	WALL INSTALLATION	INVERTED INSTALLATION	CEILING INSTALLATION
Top Discharge	Top Discharge	Top Discharge	Top Discharge
Front Discharge	Front Discharge	Front Discharge	Front Discharge
Fully Recessed	Fully Recessed	Fully Recessed	Fully Recessed
Semi-Recessed	Semi-Recessed	Semi-Recessed	Semi-Recessed

AAF herman nelson

American Air Filter
COMPANY, INC.
LOUISVILLE, KENTUCKY

Better Air is Our Business!

AAF

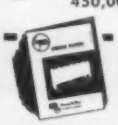
ELECTRO-CELL with Type H Washer—high efficiency air cleaning with pushbutton maintenance — the washer as an integral part of the unit simplifies installation.

herman nelson

UNIT BLOWERS, in both forward curve and backward curve wheel types, efficiently solve all ventilating and exhaust problems.

herman nelson

PORTABLE HEATERS supply extra "heat on wheels" at this cold loading dock. There is a size and model for every job, capacities 75,000 to 450,000 BTU.



Write for free literature!

AMERICAN AIR FILTER COMPANY, INC.
373 Central Avenue, Louisville 8, Kentucky

Please send me complete information on the following equipment:

- ☐ Console Heaters
- ☐ Unit Blowers
- ☐ Centrifugal Fans
- ☐ Electro-Cell Air Filters
- ☐ Dust Collectors
- ☐ Portable Heaters
- ☐ Steam Specialties
- ☐ _____

NAME _____

FIRM NAME _____ POSITION _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____

Heating Piping & Air Conditioning

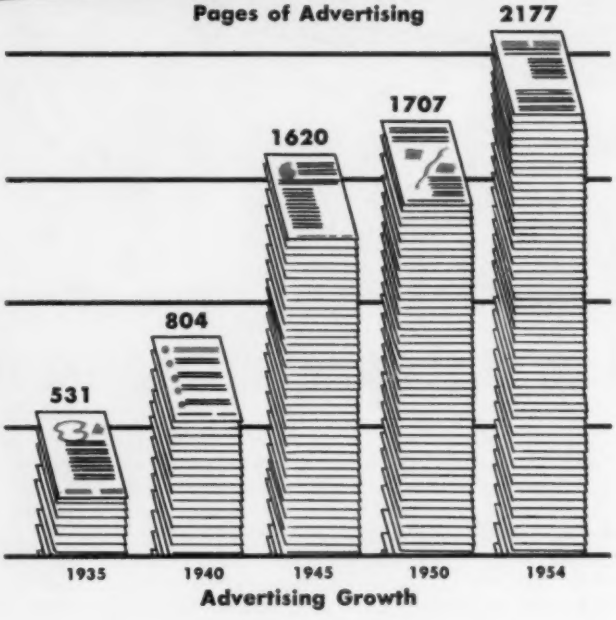
by every measure THE CHOICE in the industrial-large building field.

1st in Advertising Volume . . .

By using more space in Heating, Piping & Air Conditioning — nearly twice as much as in the field's next book — manufacturers acknowledge HP&AC the best buy for covering the engineers and contractors who purchase-control the industrial-large building market's vast product requirements.

Each year HP&AC moves farther out front, GAINING rather than losing ground. Here is your assurance of a dynamic medium . . . one whose superior editorial performance fosters growth in every respect.

Consistent advertising leadership is but one of numerous "tangibles" which individually testify to HP&AC's value as a powerful selling force. Collectively, these "tangible measures" prove conclusively the No. 1 position of HP&AC.



KEENEY PUBLISHING 6 N. Michigan, Chicago

ABC AIR CONDITIONING HEADQUARTERS ABP

1st in Reader Preference

Year in, year out, HP&AC has a high renewal rate. Subscribers rely on it as "the field's authority in print."

1st in Editorial Volume

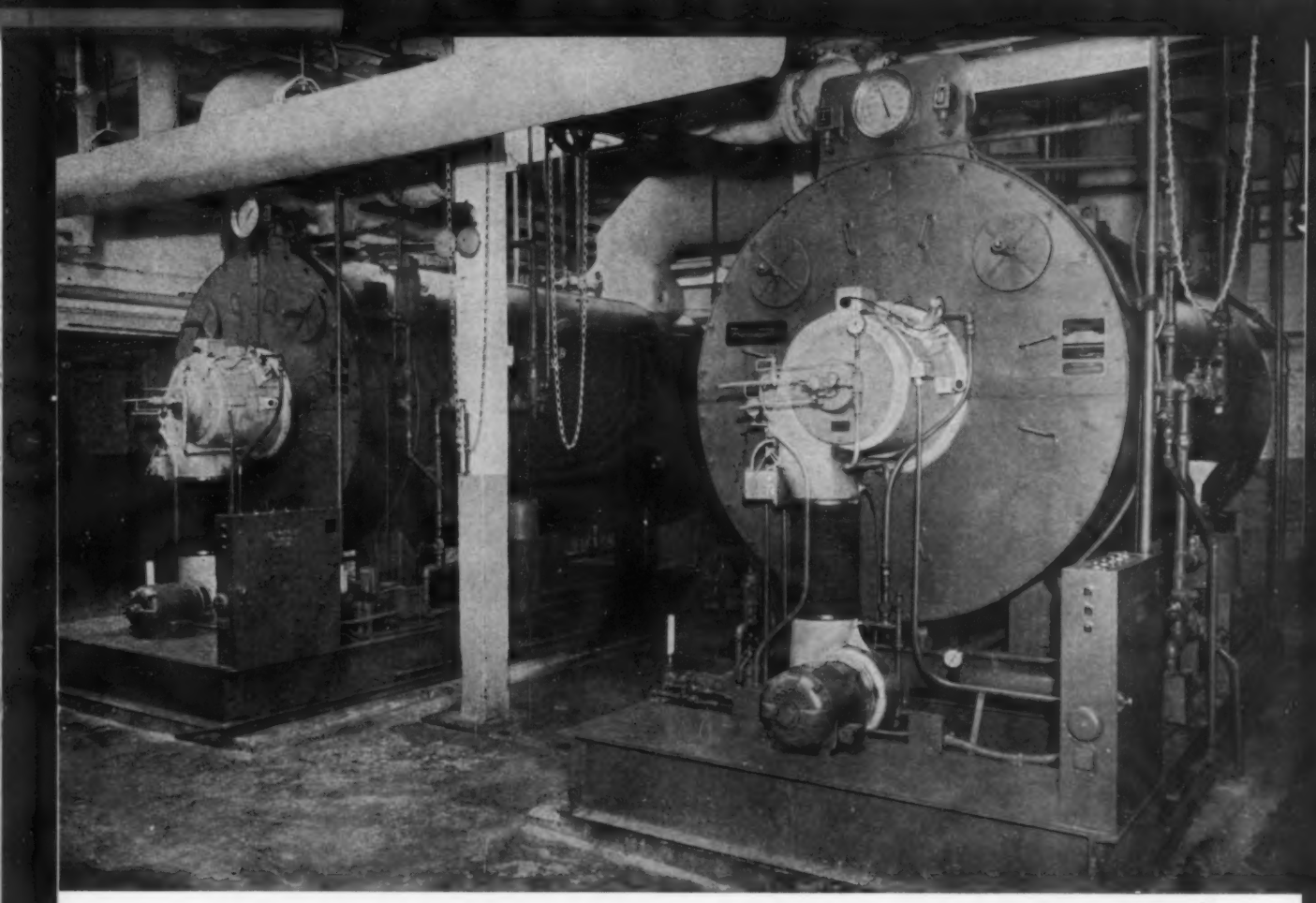
HP&AC has the greatest editorial content. Carries monthly Journal of American Society of Heating and Air-Conditioning Engineers.

1st in Advertisers' Acceptance

More companies advertise in HP&AC. In addition, HP&AC is used exclusively in its field by more advertisers.

1st in Circulation

Not only does HP&AC deliver the most circulation, it is the only FULLY paid (ABC) circulation magazine in its field.



$9,040 Saving in Steam Cost

WITH *Powermaster*® PACKAGED AUTOMATIC BOILERS

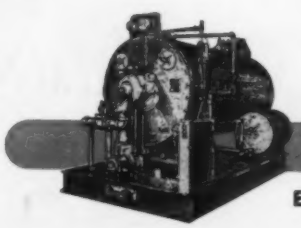
You get MORE than low-cost steam with Powermasters:

- ★ Low-cost, space-saving installation
- ★ Fast steaming
- ★ Instant response to load changes
- ★ Quick fuel change-overs
- ★ Clean, dry steam
- ★ Automatic operating and safety controls
- ★ High fuel economy at all loads
- ★ Clean, quiet operation
- ★ Smokeless combustion
- ★ One-source responsibility for complete unit
- ★ Nation-wide factory-trained service organization
- ★ Pay-As-You-SAVE Purchase Plan

These two 200 HP *Powermaster* Packaged Automatic Boilers are saving 50% of steam costs annually for a large manufacturer of clothing. In addition, they are providing hotter, drier steam for processing and comfort heating.

Completely factory assembled and fire-tested *Powermasters* have gained world-wide acceptance as dependable producers of low-cost steam or hot water. And now, you can put a *Powermaster* in your plant or building on the Pay-As-You-SAVE Purchase Plan, that helps you pay for your new boiler out of its own savings.

Write for Bulletin 1220, or ask our representative to explain why it pays to modernize with *Powermaster*.



Powermaster®

PACKAGED AUTOMATIC BOILERS

In sizes to 500 HP; pressures to 250 psi.

ORR & SEMBOWER, INC.

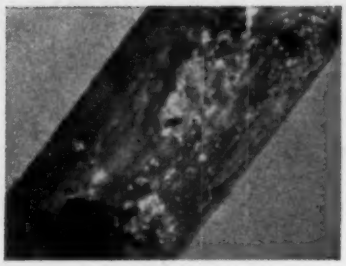
Established 1885 • Morgantown Road, Reading, Pa.

LOOK WHAT CAN HAPPEN TO THE WOOD IN COOLING TOWERS

Unretouched photographs

Unprotected cooling tower redwood
RESULT OF CHEMICAL ATTACK
Unprotected cooling tower redwood
RESULT OF FUNGUS ATTACK

PRESSURE CREOSOTING ADDS YEARS OF LIFE TO HALSTEAD & MITCHELL COOLING TOWERS



FUNGUS ROTTED UNPROTECTED DECKING

Unretouched photographs

CLEAN PRESSURE-CREOSOTED DECKING

Examine these unretouched photographs carefully. Constantly wetted wood decking in a cooling tower is subject to immediate attack by fungus and marine parasites. It is also subject to chemical deterioration from acids in water. All wood used in Halstead & Mitchell Cooling Towers is protected against these twin enemies.

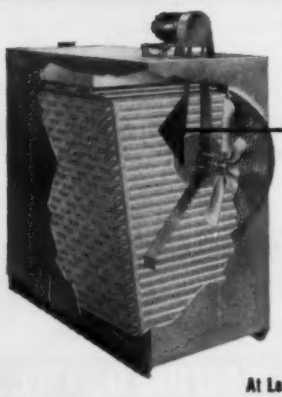
WHY PRESSURE CREOSOTING?

Creosote . . . *with 162 elements toxic to fungus growth and parasites* . . . also makes wood more resistant to chemical attack. Deep penetration of the wood by Koppers Pressure-Creosoting gives the longest possible wetted decking life. Therefore, all Halstead & Mitchell Cooling Tower decks are Pressure-Creosoted, and are guaranteed against rotting due to fungus growth . . . for 20 years!

ONLY HALSTEAD & MITCHELL OFFERS THE

20-Year Guarantee!

ON THE WETTED DECK SURFACE against rotting by fungus attack



2 thru 100 Tons

Sheet-Steel Cabinets, 5-times protected
Stainless Steel Fans and Shafts
Weather Shielding
Everdur Bolts for ease of disassembly at any time.

HM Halstead & Mitchell

At Leading Refrigeration & Heating Wholesalers Everywhere

OFFICES: Bessemer Bldg., Pittsburgh 22, Pa.

HELP—

when you need it!

You'll like AIRTEMP'S "helping hand" policy of doing business!

You'll find that Chrysler Airtemp people are helpful. Factory, field representative and distributor, all are ready to lend you a hand.

Airtemp helps you — as a *specialist!* Because Airtemp makes *only* air conditioning equipment, Airtemp gives you undivided attention on sales, application, inventory, credit, service, and other problems.

Airtemp helps you — with *advertising* and *merchandising!* National advertising plus promotion assistance on a local basis.

Airtemp helps you — as a *pioneer!* Beginning in "Packaged" air conditioning in 1937, Airtemp has a thorough understanding of dealer problems in this field.

Airtemp helps you — as the *leader!* With more Airtemp packaged units sold than any other make, Airtemp has a name and reputation to uphold. This is your assurance of a continuous conscientious dealer relationship!

Airtemp helps you — with a *complete line!* Ten models! Both water-cooled and waterless! From 2 to 15 H.P.

For complete information on how Airtemp can help YOU, write to: Airtemp Division, Chrysler Corporation, Dayton 1, Ohio.

Packaged Waterless (Air-Cooled) Air Conditioners— no water needed, no plumbing required. 2, 3, 5 and 7½ H.P.

Packaged Water-Cooled Air Conditioners in 6 models, from 2 to 15 H.P.

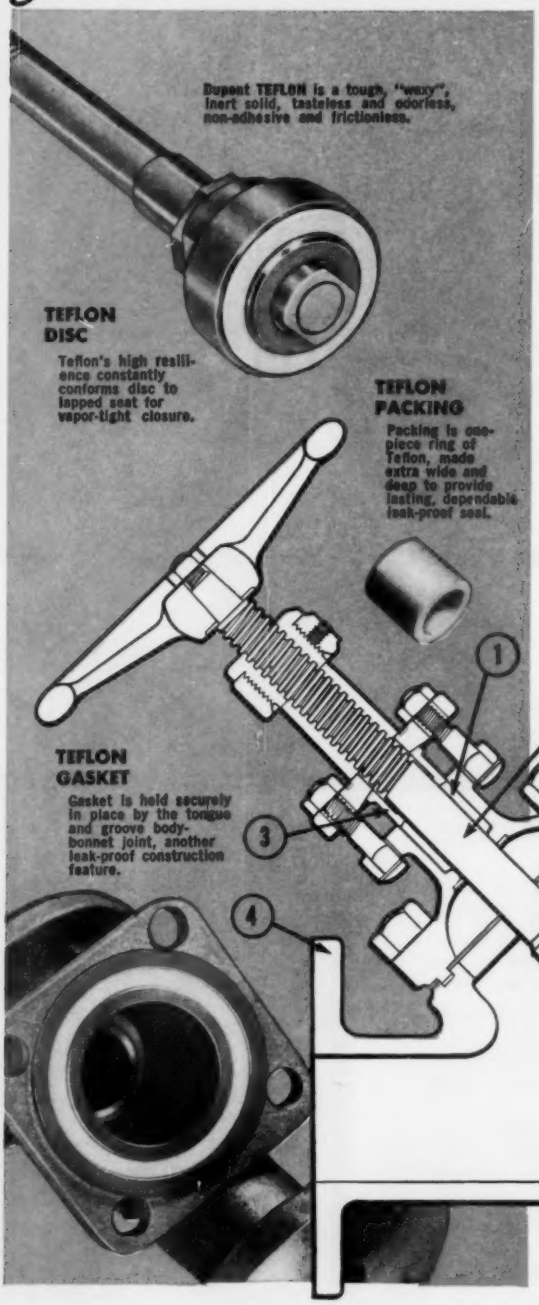
"the line that pays"

Airtemp

DIVISION OF CHRYSLER

AIR CONDITIONING • HEATING FOR HOMES, BUSINESS AND INDUSTRY

Jenkins designed for trouble-free performance... a


Dupont TEFLON is a tough, "waxy", inert solid, tasteless and odorless, non-adhesive and frictionless.
TEFLON DISC
Teflon's high resilience constantly conforms disc to lapped seat for vapor-tight closure.
TEFLON PACKING
Packing is one-piece ring of Teflon, made extra wide and deep to provide lasting, dependable leak-proof seal.
TEFLON GASKET
Gasket is held securely in place by the tongue and groove body-bonnet joint, another leak-proof construction feature.
1
2
3
4

STAINLESS STEEL "Y"

to lower costs in a wider range of

CORROSIVE SERVICES

For food and chemcial plants, and similar services, Jenkins Fig. 1335 "Y" Globe offers many advanced features that will lower operating costs and keep your processing lines trouble-free. The disc, packing, and gasket are tough, resilient Teflon. Tasteless and odorless, it eliminates problems of contamination.

The "Y" pattern permits full flow, nearly equal to that of a gate valve, and also provides the vapor-tight closure and the ease of disc renewal of a globe valve.

Fig. 1335 offers extra value by any test . . . *initial cost, operating efficiency, low maintenance.* You can convert this extra value into *extra savings* on your toughest corrosive services. Call your Jenkins Distributor, or write: Jenkins Bros., 100 Park Ave., New York 17.

FULL, FREE FLOW through Fig. 1335 is nearly equal to flow through a gate valve.

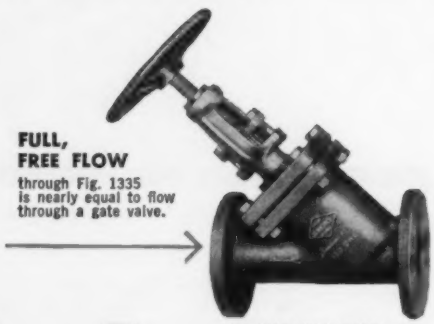


Fig. 1335 "Y" GLOBE
150 lbs. O.W.G. at 500°F
230 lbs. O.W.G. at 100°F
Sizes 1" to 4"

(1) **Packing Box**—Exceptionally deep and wide to hold optimum size packing.

(2) **Spindle**—Polished shank, long-operating threads, bevel shoulder for backseating.

(3) **Gland**—Two-piece for equalized pressure, tight seal.

(4) **Flanges**—Conform to M.S.S. Standard Practice S.P.42 Specifications.

JENKINS STAINLESS STEEL VALVE BOOKLET illustrates and describes wide range of Jenkins Globe, Gate, Check, and Y Valves, includes selection data, survey forms. Ask for Form 200-A.

JENKINS VALVES

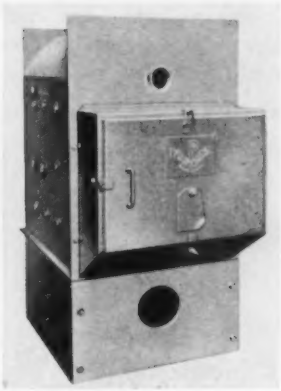
LOOK FOR THE JENKINS DIAMOND

SINCE 1864 TRADE JENKINS MARK

Jenkins Bros.

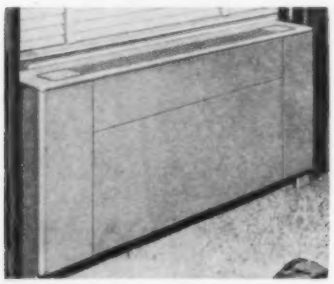
EQUIPMENT DEVELOPMENTS . . .

For reviews of Recent Trade Literature see Page 227



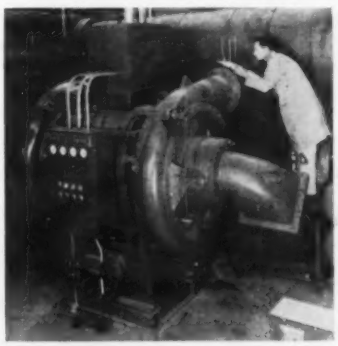
Front Flue Door . . .

. . . redesigned for company's commercial, residential line of boilers—Portmar Boiler Co., 193 Seventh St., Brooklyn 15. Of benefit where restricted stack, poor flue construction exists, says company. Steel stamped of flanged and dished construction. Designed for increased furnace volume, cleaner operation. All heating surfaces accessible through door for cleaning, inspection.



Room Conditioners . . .

. . . for summer cooling, winter heating—American Blower Corp., Detroit 32. "Diaflo" units feature compactness, uniformity of air discharge, quietness of operation. For hospitals, hotels, motels, offices, schools, office buildings. Feature new type fan extending full active length of discharge outlet. Fan design based on line flow principle, said to permit straight through air movement from one side of fan to other. Evenness of discharge across full length of unit insures maximum uniformity in heating, cooling, says company. Line flow principle permits design of compactness, high gravity convector capacity. Means reduction in fan wheel diameter, resulting in minimum overall depth (9¼ in.). Special mountings for both ends of fan rotor facilitate quietness, manufacturer reports. Factory built enclosures slipped on after piping, wiring completed. Uses throwaway or cleanable type filters. In five sizes with nominal lengths 18, 27, 39, 48, 54 in. With rated air deliveries 200 to 600 cfm. Unit consists of three parts: basic unit, enclosure, enclosure cover. Can be installed vertically as free standing, fully or semi-recessed unit; horizontally as ceiling mounted unit.

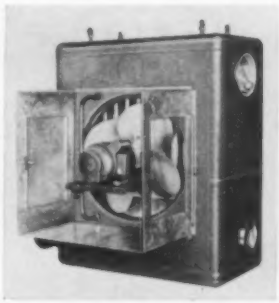


Water Chillers . . .

. . . with refrigeration capacities to 800 tons—Trane Co., LaCrosse, Wis. "CenTraVacs" powered by 600 hp squirrel cage motors. Cited features: hermetic seal, economical part load operation down to 10 percent, automatic operation, freedom from vibration, long life.

Solvent Welding . . .

. . . pipe fittings, flanges of injection molded unplasticized polyvinyl chloride—Tube Turns Plastics, Inc., Louisville. First produced on commercial scale by injection molding process, says company. Line includes 90 and 45 deg elbows, tees, unions, couplings, caps, reducing bushings, flanges. Designed for fast installation with minimum of tools, equipment.



Oil Fired Unit Heater . . .

. . . with duct frame—Delta Heating Corp., Cole St. and Reading RR, Trenton 8, N. J. Series "UHE," with horizontal louvers, has galvanized frame, around propeller fan, motor assembly for attachment of duct. In six sizes 110,000 to 280,000 Btu per hr output. Company also announces "UH" heater with vertical louver frame. Standard louvers behind frame control horizontal flow and combine with frame to spread heated air in any proportion.

Welder . . .

. . . for pipelines, construction, maintenance work—General Electric Co., Schenectady 5, N.Y. Is 200 amp engine driven type. For d-c or a-c/d-c electrodes 1/16 to ¼ in. Cited features: minimum load drop-off as welder heats up, lively arc and fast response, ease in arc welding, high instantaneous recovery voltage preventing popouts.

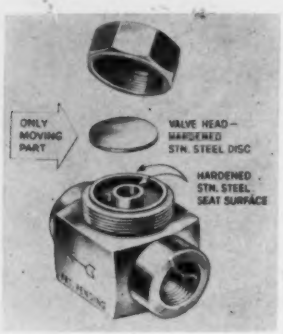
Air Conditioning Unit . . .

. . . with broad application range—Rheem Mfg Co., 7600 S. Kedzie Ave., Chicago 29. As window unit is equipped with air panel, when used

EQUIPMENT DEVELOPMENTS

Continued

for ductwork connection, duct panel replaces air front. With ductwork may be used for summer air conditioning for small commercial structures. In ¾ to 2 hp models to condition areas to 1200 sq ft.

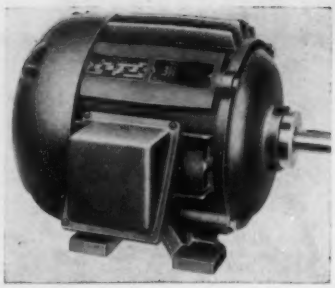


Steam Trap . . .

. . . for pressures 10 to 600 psi, temperatures to 950 F—Sarco Co., Inc., Empire State Bldg., New York 1. Is thermodynamic type. Uses kinetic energy of steam to close valve. Valve disc is only moving part. Stainless steel construction.

Positioning Relay Kit . . .

. . . for field application to air operated control valves—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10. Solves problems of stuffing box friction load, poor response, unbalanced inner valves, hysteresis, undesirable regulating characteristics, company reports. Standard SAMA 3-15 or 3-27 signal ranges actuate force balance mechanism. Direct or reverse acting. Suitable for top or bottom connected valves.



Motors . . .

. . . with corrosion-resistant cast iron frames, improved winding insulation, heavy duty ball bearings—Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14. In standard, explosionproof totally enclosed models. Grease fittings at top and bottom of bearing housing permit lubrication, removal of old grease. Capacities: 1 to 10 hp, 4 pole, 60 cycles. In rerated NEMA frames 182 to 256U.

Dual Fuel Burner . . .

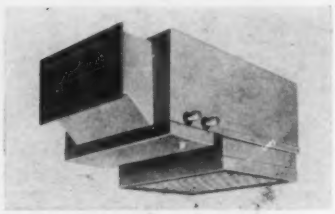
. . . in three sizes over 15 to 92 hp range for low pressure gas, light fuel oil—Webster Engineering Co., P.O. Box 2168, Tulsa 1, Okla. Is assembled, prewired, tested package. Standard units include programming electronic combustion safeguard system. Special circuitry available to meet local code requirements.

Metal Insert Fittings . . .

. . . for plastic pipe—Union Malleable Mfg. Co., Ashland, Ohio. In zinc plated malleable iron, brass. For joints where strain, stress need added strength of metal.

Baseboard Diffuser . . .

. . . for warm air heating systems—Kritzer Radiant Coils, Inc., 2901 Lawrence Ave., Chicago 25. "Air Base" arranged for easy installation with snap-on front cover, built-in balancing damper, optional shutoff damper. In standard sizes.



Air Conditioner . . .

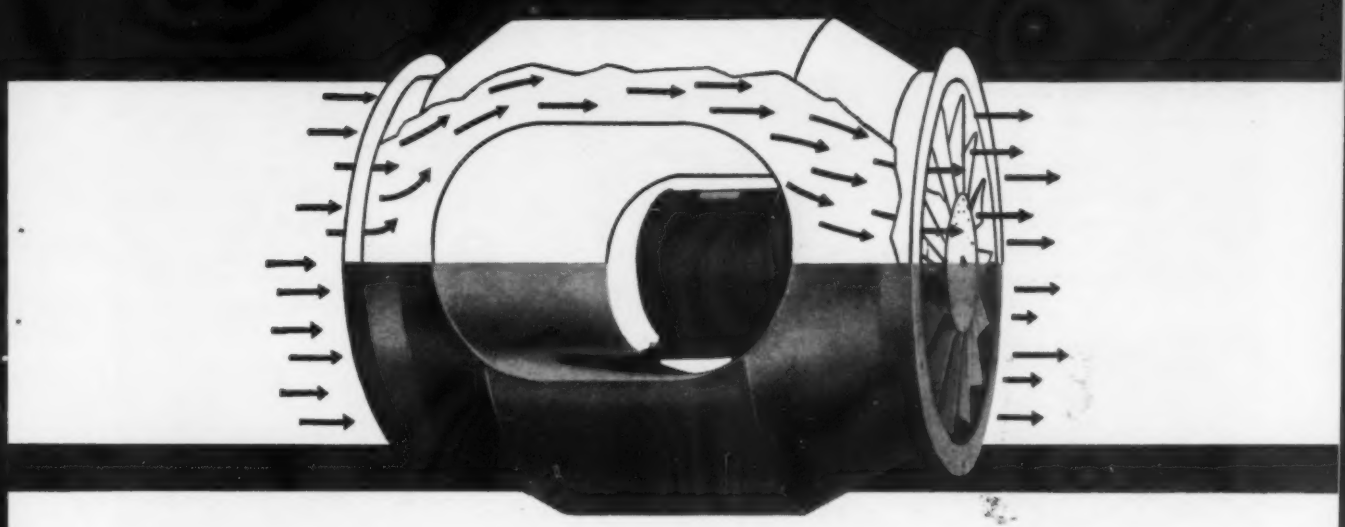
. . . designed for simplicity, quietness—Refrigeration Engineering, Inc., 7250 E. Slauson Ave., Los Angeles 22. In three sizes for direct expansion systems or chilled, hot water systems. For multiple installation in motels, hotels, offices. Individually controlled. Fits into unused areas. Requires no ducts.

Level, Flow Controller . . .

. . . with variations engineered for flexibility—Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33. Modifications are tube-in-probe, differential, time delay "Tektors." Differenetial unit, shown, designed for high, low level control using one instrument.

Gas Fired Unit Heater . . .

. . . designed for suspended installation—Day & Night Div. of Carrier Corp., 700 Royal Oaks Dr., Monrovia, Calif. "Delayed action" fan op-



New catalog explains

EXHAUSTING FUMES THE *DIRECT WAY*

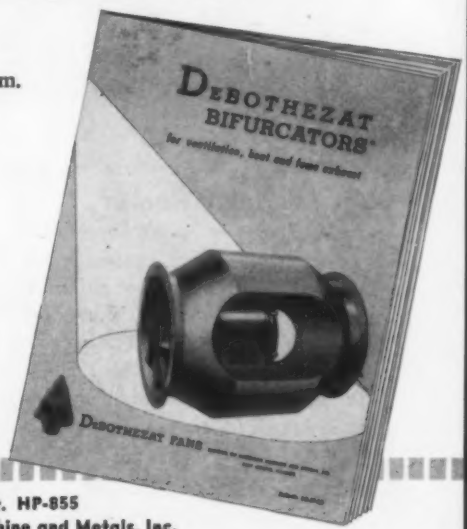
and contains "fan information" section

Reserve your copy of this new Bifurcator® Fan catalog now being printed. The catalog goes into detail on the *direct* way in which the Bifurcator Fan exhausts fumes . . . and also includes the latest improvements made in the Bifurcator Fan itself. This catalog is packed with up-to-date information on Bifurcator sizes and capacities, dimensions, volume and pressure fan wheels, protection against corrosion, and certified capacity ratings.

You'll also find data that's handy in solving many a ventilation problem. For in the catalog is helpful fan information like . . .

- definitions and fan laws
- how to determine static pressure
- velocity pressure table
- friction chart
- loudness level table

So be sure to reserve your copy by mailing the coupon.



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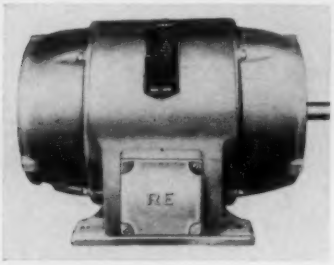
ATTENTION OF MR. _____

EQUIPMENT DEVELOPMENTS

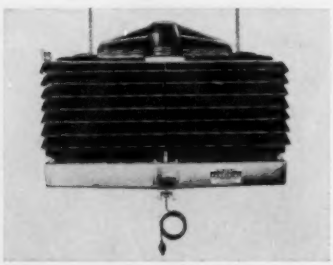
Continued

eration allows element to heat, eliminating "cold blast" starting, says company. For natural, manufactured, LP gas. In eight sizes, 50,000 to 225,000 Btu input ratings.



Motor Design . . .

. . . for single frame combinations of motors, brakes, fluid couplings, gear reducers—Reuland Electric Co., Alhambra, Calif. Achieved through use of standard interchangeable assemblies made to order on each job. In ½ to 15 hp ratings.

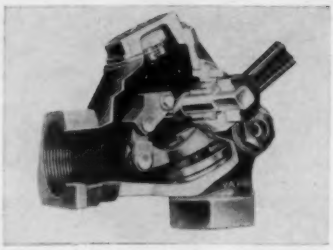


Gas Fired Unit Heater . . .

. . . designed for silent operation, needing no electrical connections—Thermobloc Div. of Prat-Daniel Corp., South Norwalk, Conn. Provides infrared rays for heating. In two sizes with 62,000 and 125,000 Btu inputs. Uses natural, manufactured, mixed, LP-air gas.

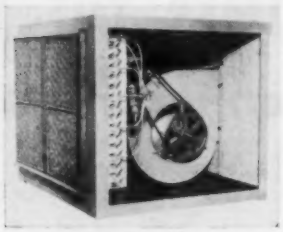
Air Conditioner . . .

. . . with higher power factor, lower current requirements—General Electric Co., Appliance Park, Louisville. New ½ hp, 115 volt model draws 40 percent less current than ½ hp unit for 1954, says company. An electrical characteristic, the higher the power factor, the lower the amperes used for same motor load.



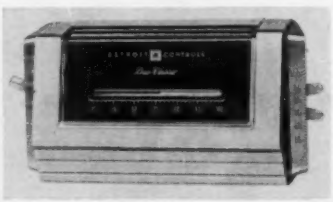
Steam End Valve . . .

. . . for use at end of railroad passenger cars, diesel locomotives to control high pressure train line—Vapor Heating Corp., 6420 W. Howard St., Chicago 31. Is believed to have other industrial applications. New mechanical linkage inside valve multiplies lever pressure for opening against 250 lb steam pressure.



Cooling System . . .

. . . is "8ACCU" remote air cooled condensing unit coupled with "8LSU" low side air handling unit—Typhoon Air Conditioning Co., Inc., 505 Carroll St., Brooklyn 15. "8LSU" performs cooling, filtering, dehumidifying, circulating functions throughout conditioned area. System recommended by company for small commercial structures, industrial offices, where floor space is at premium.

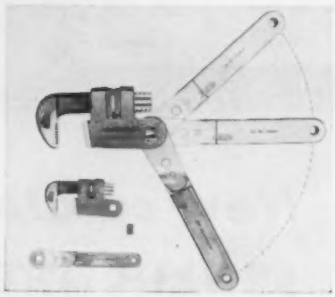


Thermostat . . .

. . . for summer air conditioning, winter heating—Detroit Controls Corp., 5900 Trumball Ave., Detroit 8. All functions controlled by single switch on thermostat. Will hold selected temperature to within fraction of a degree, says company.

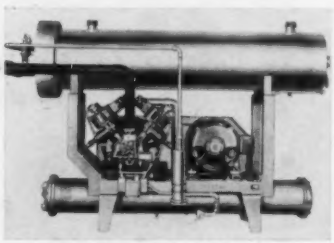
Convector Radiation . . .

. . . in 30 types, 8000 sizes—Modine Mfg. Co., 1509 De Koven Ave., Racine, Wis. Company has redesigned entire line except its type "F" floor cabinet convector. New line includes free standing, fully and partially recessed (plaster front), wall hung models. Knob type dampers optional.



Pipe Wrench . . .

. . . that "bends" by ratchet principle to permit adjustments in tight places—Tedd Products Co., P. O. Box 1621, Rockford, Ill. "Handi-Flex" also serves as conventional ½ in. ratchet wrench. For pipe, jaws are set, then handle is moved to good pulling position.

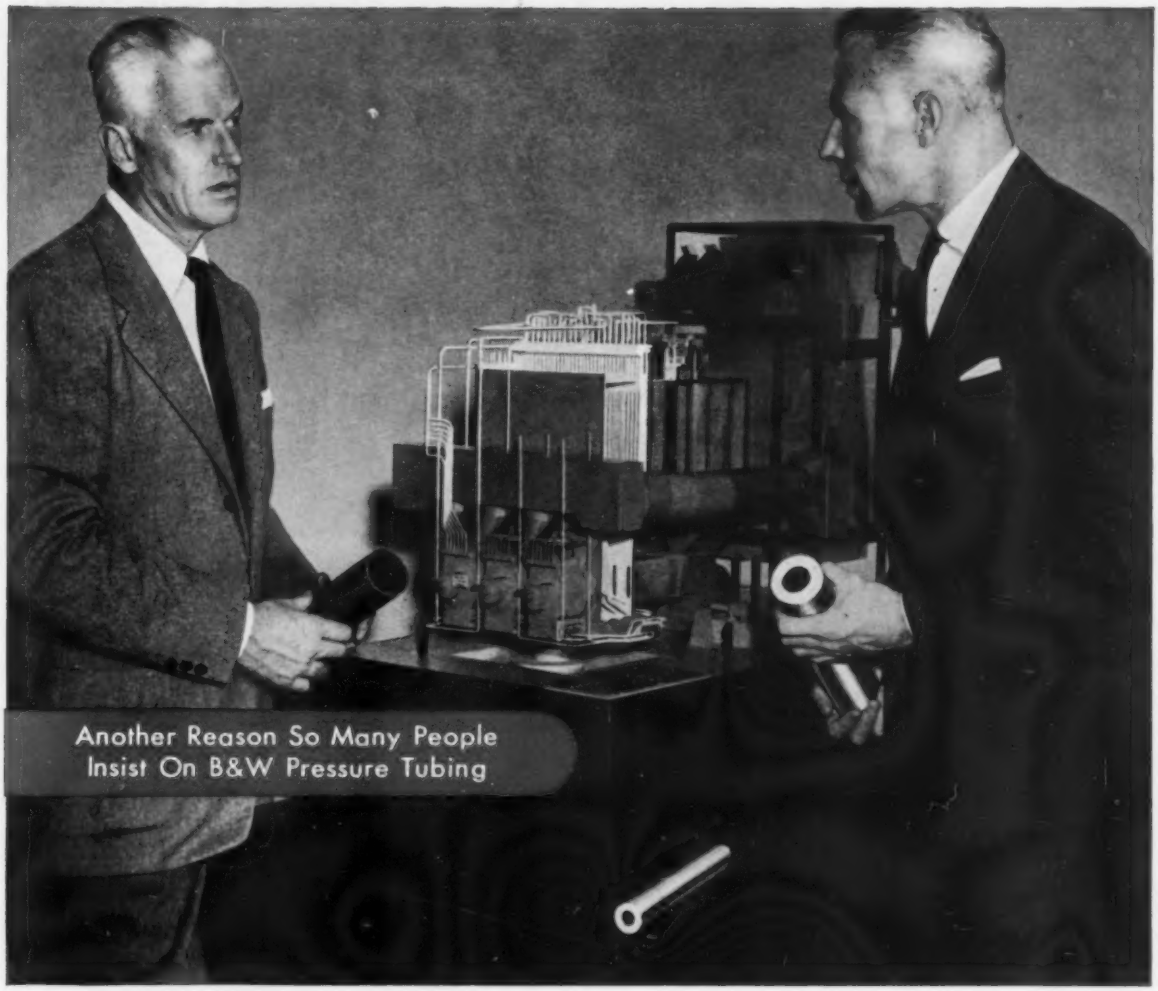


Packaged Chillers . . .

. . . in 7½ to 100 ton size range—Curtis Refrigerating Machine Div. of Curtis Mfg. Co., 1950 Kienlen Ave., St. Louis 20. Engineered with matched components for fast installation. Consist of multiple cylinder compressor, watercooled shell and tube condenser, liquid chiller, necessary controls, electrical wiring, refrigerant piping, expansion valves.

Plug Valve . . .

. . . for 200 psi oil, water, gas; 150 psi steam—Homestead Valve Mfg. Co., Coraopolis, Pa. Affords positive high pressure distribution of lubri-



UNDER PRESSURE? TRY 4500 PSI AT 1150 F

There's a new concept in big boiler design: The Universal Pressure Steam Generator. It operates either below the critical—3206 psi—or smashes through the pressure barrier. A unit now being built has a design pressure of 5500 psi, delivers steam at 4500 psi and 1150 F. It's a "once-through" unit; put water in one end of a tube and steam comes out the other, without using a steam drum.

When B&W engineers designed this new boiler they turned to their own metallurgical and tubular products experience with alloys for pressure and temperature service to devise the tubing complex that is the heart of the unit. The chart shows the variety of analyses in sizes from 1-inch O.D. to 2½-inch O.D. and wall thicknesses from 0.10-inch to 0.55-inch.

Carbon Steel • Carbon Moly
Croloy ½ • Croloy 1
Croloy 1¼ • Croloy 2¼
Croloy 3M • Croloy 9M
Croloy 18-8

The best way to avoid operating under *personal* pressure on any job is to call for B&W Pressure Tubing. There's a grade, size, length and wall for virtually every pressure, temperature and corrosion resistance requirement. *Write for Technical Bulletin 6-HP.*

B&W
TUBULAR PRODUCTS DIVISION

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa. and Milwaukee, Wis.: Seamless Tubing, Welded Stainless Steel Tubing
Alliance, Ohio: Welded Carbon Steel Tubing
Milwaukee, Wis: Seamless Welding Fittings

TA-5028(P)

"Our Janitrols save us over 40% in fuel costs"

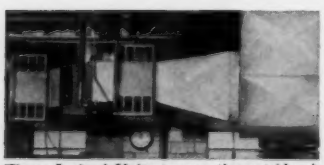
Says Mr. C. J. Mayle, President, Fremont Tool & Die Co., Fremont, Ohio, comparing Janitrol Unit Heaters with oil-fired steam heat used previously.

Here's how Janitrol engineers and equipment solved all of Mr. Mayle's tough heating problems.

● Bothersome drafts, caused by the exhaust of heated air in the removal of abrasive dusts, were eliminated by bringing in outside air, "tempered" by Janitrol DUCT Heaters. The Dura-tube heat tubes in the DUCT units minimized the corrosive effects of condensation caused by the cold outside air.

● The 'Surface' Industrial Processing Furnaces, "big brothers" to the Janitrol line, made warm spots in the shop area. Individual Janitrol Unit Heaters, with separate thermostats, provided uniform, zoned comfort throughout.

● Economical year 'round office comfort was obtained by using the same duct system for summer cooling and winter heating. The plant is ventilated in summer by the unit heater blowers.



These Janitrol Units temper the outside air which is brought in to replace the heated air exhausted in abrasive dust removal.

It is not only the superiority of Janitrol design, but also the training of its engineer-representatives who integrate and balance this equipment to meet your problem. For new, or remodeling advice, send these problems to us. No obligation.

®Janitrol Gas-Fired
UNIT HEATERS

DIVISION OF SURFACE COMBUSTION CORPORATION
400 DUBLIN AVE., COLUMBUS 16, OHIO

MAKERS OF SURFACE INDUSTRIAL FURNACES AND KATHABAR HUMIDITY CONDITIONING

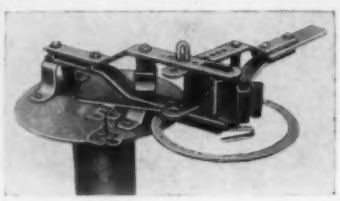
EQUIPMENT DEVELOPMENTS

Continued

cant over sealing surface, self freeing plug to prevent sticking, operating ease of cylindrical plug valve, says manufacturer. Reference book 39-5 from company details valve in 28 pages.

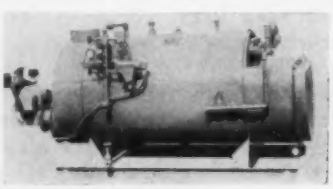
Pipe Insulation . . .

. . . for lines operating at low or alternating high and low temperatures —Owens-Corning Fiberglas Corp., Toledo 1. Designed for insulating efficiency, condensation protection. For temperatures — 120 to 250 F. Includes factory applied vapor barrier.



Bender Dies . . .

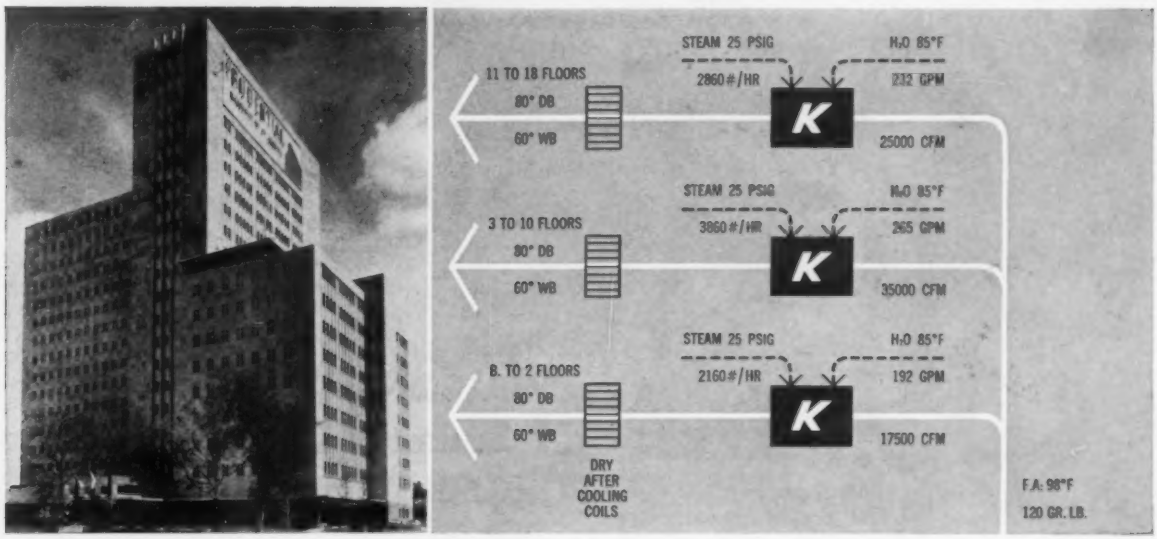
. . . for maintenance, production work —Hossfeld Mfg. Co., Winona, Minn. In six types of various sizes for bending steel tubing, pipe, conduit, flatstock. Makes round or square bends on flatstock, says company.



Hot Water Boiler . . .

. . . with tankless design operates with automatic controls—Mund Boilers, Inc., 1600 N. Indiana St., Los Angeles 63. For use where large quantities of hot water needed on

Dry comfort for health at Prudential



The Prudential Insurance Company of America knows that truly comfortable air has two dimensions: the right temperature *and the right humidity*. Their full-dimensional air conditioning reflects this modern thinking: they use the Kathabar system for humidity control, conventional cooling for temperature control.

Kathabar units dry fresh make-up air to absorb the moisture load of the entire building. This reduces refrigeration requirements for sensible cooling. Dry air eliminates the shock of ordinary air conditioning. Dry air protects health by eliminating wet coils where bacteria thrive.

The team of Kathabar humidity conditioning and refrigeration works well in many comfort and industrial applications, because each does the job it is best suited for. Find out how you can profit by the experience of Prudential and many others.

write for the Prudential story today

Kathabar®
HUMIDITY CONDITIONING

SURFACE COMBUSTION CORPORATION, TOLEDO 1, OHIO

PLAN YOUR PROCESS PIPING for

MAXIMUM SERVICE and SAFETY with . . .

WATSON-STILLMAN
Socket-Welding
FORGED STEEL FITTINGS

In high pressure steam lines...process liquid and gas piping...hydraulic fluid lines...wherever strong, tough pipe joints are needed, Watson-Stillman Socket-Welding Fittings provide a safety factor against costly piping failures. Drop-forged of high quality steel, they readily resist pressure, heat, corrosion, shock and vibration.

W-S Socket-Welding Fittings are easy to install. Deep sockets support and align the pipe for welding. No need for tack welding or special fixtures. And the outside-the-pipe fillet weld prevents welding icicles inside the pipe.

Watson-Stillman Forged Steel Fittings are available in carbon, stainless and alloy steel for Schedule 40, 80, 160 and XX pipe. Sizes ⅛" to 4". A complete line of forged screw-end fittings is also available.. Send today for Free catalogs.

Sold Through Leading Distributors

W-S WATSON-STILLMAN FITTINGS DIVISION

HKP H. K. PORTER COMPANY, INC.

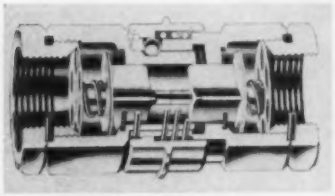
Roselle, New Jersey

11

EQUIPMENT DEVELOPMENTS

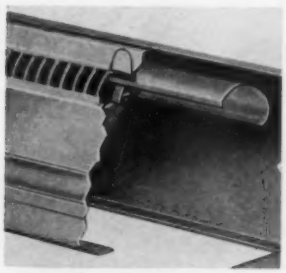
Continued

short notice. In nine models 250 to 1000 gph, 15 to 80 gpm for short periods. Gas or oil fired.



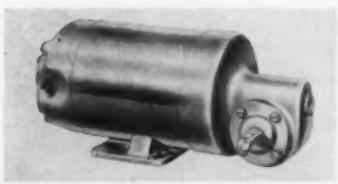
Coupling . . .

. . .for high pressure, gravity flow, vacuum—Snap Tite, Inc., Union City,, Pa. Quick connect, quick disconnect design. Is said to provide instant line shutoff when equipped with valves. In sizes 1/8 to 3 in. ID. Sizes to 10 in. available to order.



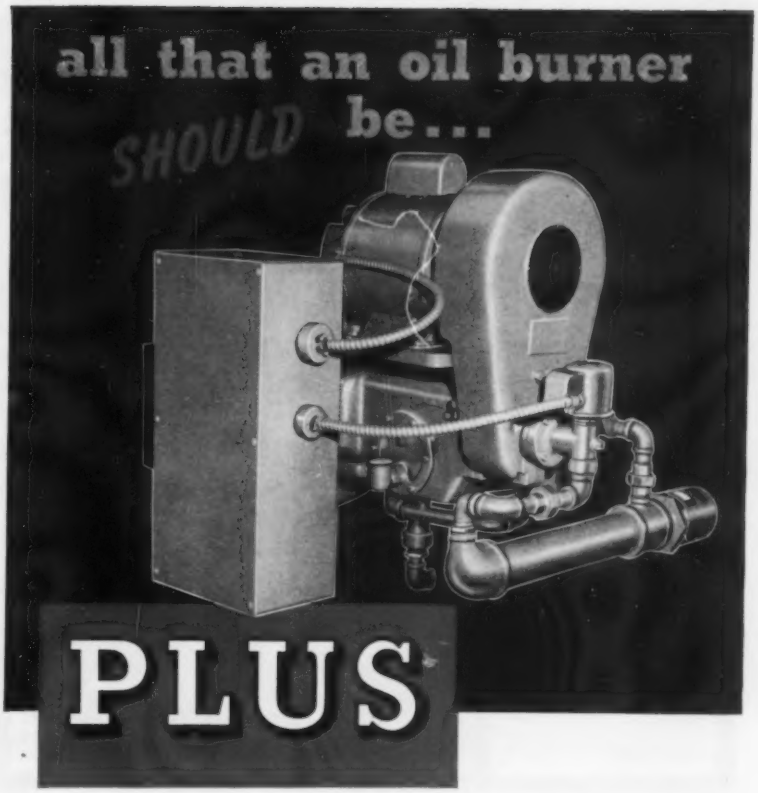
Baseboard Diffuser . . .

. .with built-in damper for perimeter heating systems—Air Control Products, Inc., Coopersville, Mich. Has sliding "Adjusto Bottom" base strip. Damper designed to maintain constant air pattern at any degree of opening. "Adjusto Bottom" eliminates need for cutting, fitting in installation.

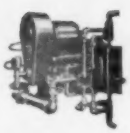


Gearmotors . . .

. . .in NEMA 42 frame, 1/20 and 1/12 hp ratings—Doerr Electric Corp., Cedarburg, Wis. In eight standard ratios, 5:1 to 60:1. Motors can be split phase, capacitor start-

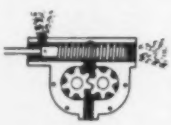


Designed and built to provide the most complete combustion with an absolute minimum of supervision and maintenance, Superior Rotary Burners combine the best time-tested features of horizontal rotary atomization with dependable automatic firing, plus . . .



THE 4-HOLE HINGE

This hinge has the effect of placing the primary pump between the fuel oil tank and the oil heater, permitting higher oil temperatures as required by modern catalytic oils, and eliminating the pump strain in pulling cold oil through the heater.



MORE POSITIVE VISCOSITY CONTROL

Superior's Constant Oil Rate Control provides uniform firing *throughout the entire firing range of the burner* regardless of viscosity variations in the fuel.

CONSTANT GAS PILOT

On Superior Combination Gas/Oil Burners, a continuous gas pilot remains lighted throughout all stages of the gas-firing cycle. Insurance records show that constant gas pilots provide the maximum operating safety. Superior's constant-burning gas pilot provides the greatest protection and the most positive ignition known to modern gas combustion . . . write for Catalog 2604.

for performance you can **BANK** *on*

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 18, N.Y.

SUPERIOR ROTARY BURNERS

BARBER COLMAN

New Wheelco Combustion Safeguards

A totally new standard in combustion safeguards for all fuels!

For all types of commercial and industrial heating equipment . . . whether gas- or oil-fired . . . the *all-new* Wheelco Flame-otrol gives you a new measure of protection against flame failure hazards, plus wider selection of detection systems for maximum design flexibility, ease of installation, and freedom in choice *and use* of burners, pilots, and fuels.

Manual or *automatic* models give you total burner and fuel shutdown, plus true "safe-start" operation, with automatic delay for the safe-start circuit!

Phone your nearby Wheelco Representative for help in designing and installing a properly integrated *electronic* combustion safeguard system for single- or multiple-burner applications.

Write for complete facts

Helps you specify . . . gives you information on six outstanding design features of the *all-new* Wheelco Flame-otrols . . . describes exclusive user-benefits never before offered in a low-cost instrument. Write for Bulletin F-6570, *today!*

WHEELCO INSTRUMENTS DIVISION

BARBER-COLMAN COMPANY, DEPT. T, 1507 ROCK ST., ROCKFORD, ILLINOIS
BARBER-COLMAN OF CANADA, LTD. • TORONTO, ONTARIO, CANADA

Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Small Motors
Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

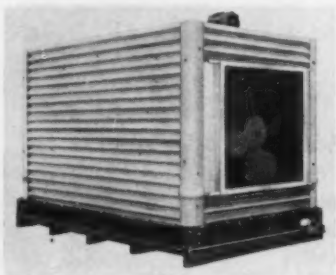
EQUIPMENT DEVELOPMENTS

Continued

induction run, capacitor start-capacitor run, polyphase; open and totally enclosed.

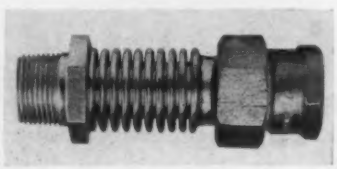
Air Conditioners . . .

. . . in 10 and 15 ton self contained models—Frigidaire Div., General Motors Corp., Dayton. Feature twin cooling system for control of temperature, humidity when full load not required. Steam heating coils available for year 'round service.



Cooling Towers . . .

. . . for air conditioning, refrigeration in 5 to 50 ton capacities—Marley Co., 222 W. Gregory Blvd., Kansas City, Mo. Of wood mechanical draft design. With forced draft, vertical air discharge. For use where corrosion is major problem.



Flexible Nipple . . .

. . . for misaligned headers to boiler connections, misaligned piping, vibra-

BARBER COLMAN

ELECTRIC-ELECTRONIC

Control Centers

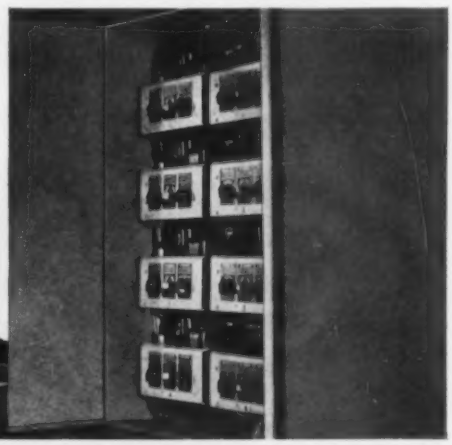
. . . simplified air conditioning system installation in new office building of . . .

MONONGAHELA POWER COMPANY

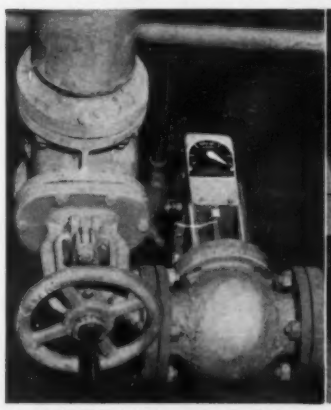
It's Barber-Colman throughout! From the electric-electronic controls in modern Control Centers, to the Uni-Flo engineered air distribution, this new home office of Monongahela Power Company has the very latest equipment for modern-day comfort. Desired temperature levels are maintained in the 150 rooms the year round, with a minimum of attention. Each of the eight zones has its own control system for maximum flexibility at minimum cost.

Architect: C. E. SILLING & ASSOCIATES, Charleston. *Mechanical Engineer:* JOHN PAUL JONES, CAREY & MILLAR, Cleveland. *General Contractor:* SOUTHEASTERN CONSTRUCTION CO., Charleston. *Mechanical Contractor:* STUART-McMUNN CO., Clarksburg.

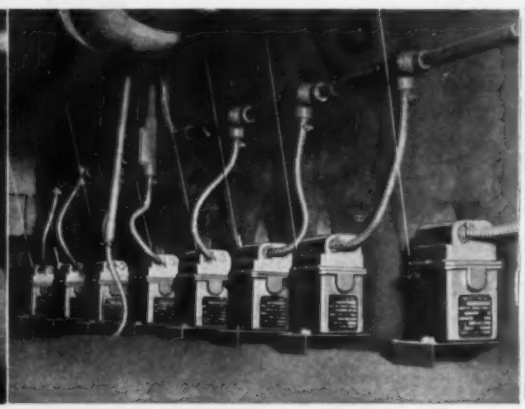
$1,500,000 General Headquarters Office Building of Monongahela Power Company in Fairmont, West Virginia. This is "nerve center" of utility serving over 200,000 customers in a 12,596 square mile area. Complete building has all-year air conditioning.



Control Centers function as central junction boxes, house pre-wired accessories, numbered terminal strips for connecting all electrical components. Wiring is simplified, installation decreased, servicing minimized.



Motor-Operated Valves, with oil-submerged operators, provide control of heat exchangers and chilled water supply.



Barber-Colman Control Motors, proportioning-type, operate hot and cold deck dampers. Long and dependable operation assured by oil-submerged motor switches and gear train.

Legible, easily read dials, convenient for authorized personnel, are exclusive with Barber-Colman Electronic Controls.

You would expect electrical power engineers to favor *electrical* controls. After all, these experts are familiar with the speed, flexibility, accuracy, and reliability of electrical equipment. Utility companies make it a policy to use and recommend latest developments in the electric-electronic world.

Monongahela Power Company engineers followed those lines of thought in approving the Barber-Colman system of electric-electronic temperature control. Outdoor reset controls position motor-operated valves in accordance with outdoor conditions. Two averaging-type thermostats in each zone actuate an averaging control in the respective Control Center, positioning mixing dampers. The result is a dependable, simplified control system which provides comfortable warmth or refreshing cool air in varying degrees to each zone, taking into consideration outdoor temperatures, internal loads, solar exposure, and requirements of the occupants.

Barber-Colman application engineers are available in a nearby Field Office, or write us for data, prices, and information on any automatic control problem.

Barber-Colman Company

DEPT. T, 1301 ROCK ST., ROCKFORD, ILLINOIS, U. S. A.

Field Offices in principal cities

Automatic Controls • Air Distribution Products • Industrial Instruments
Aircraft Controls • Small Motors • Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

RIDGID
PIPE THREADERS

NO. 504 . . . easy to set-up . . . fast to use . . . precision made . . . gives perfect threads every time.

Today, craftsmen demand more from pipe tools. They buy tools based on performance . . . accuracy . . . dependability . . . and long service life. That's why RIDGID Tools are number *ONE* in demand.

NO. 4P geared die stock gives perfect threads on 2½" to 4" pipe with four sets (5 each) of dies.

SPECIFY THE RIDGID "502"
for use on any power drive. Single set of self-contained dies adjusts quickly to ½" and ¾" pipe . . . regardless of position of quick opening lever.

NO. 65R for perfect threading by hand or with power . . . for use on 1" to 2" pipe . . . jam-proof.

SPECIFY THE RIDGID "504"
for use on any power drive. One set of full width dies adjusts to 1", 1¼", 1½" or 2". Quick-opening dies retract immediately while power drive is operating . . . eliminates slow back-off. Four-jaw work-holder sets to size instantly . . . no lead screw jam.

CONDUIT THREADERS AVAILABLE

Small Ratchet threaders capacity from ⅛"-2".

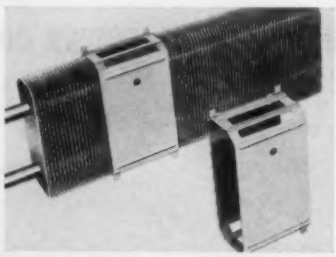
RIDGID
WORK-SAVER PIPE TOOLS

MANUFACTURED BY THE RIDGE TOOL COMPANY • 402 CLARK STREET • ELYRIA, OHIO

EQUIPMENT DEVELOPMENTS

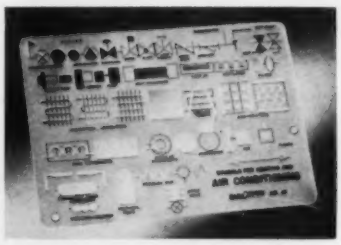
Continued

tion or pipe movement due to expansion or contraction —Techniflex Corp., Port Jervis, N. Y. All bronze-brass construction. In standard sizes ⅜ to 2½ in. IPT with union fitting on one end, male fitting on other. Fittings, lengths available for special requirements.



Sliding Shoe . . .

. . . for dual tube baseboard heating coils—Kritzer Radiant Coils, Inc., 2901 Lawrence Ave., Chicago 25. With two piece "snap around" design. Cited features: keeps fin edges from touching front or back of baseboard cover, protects all four sides of coil.

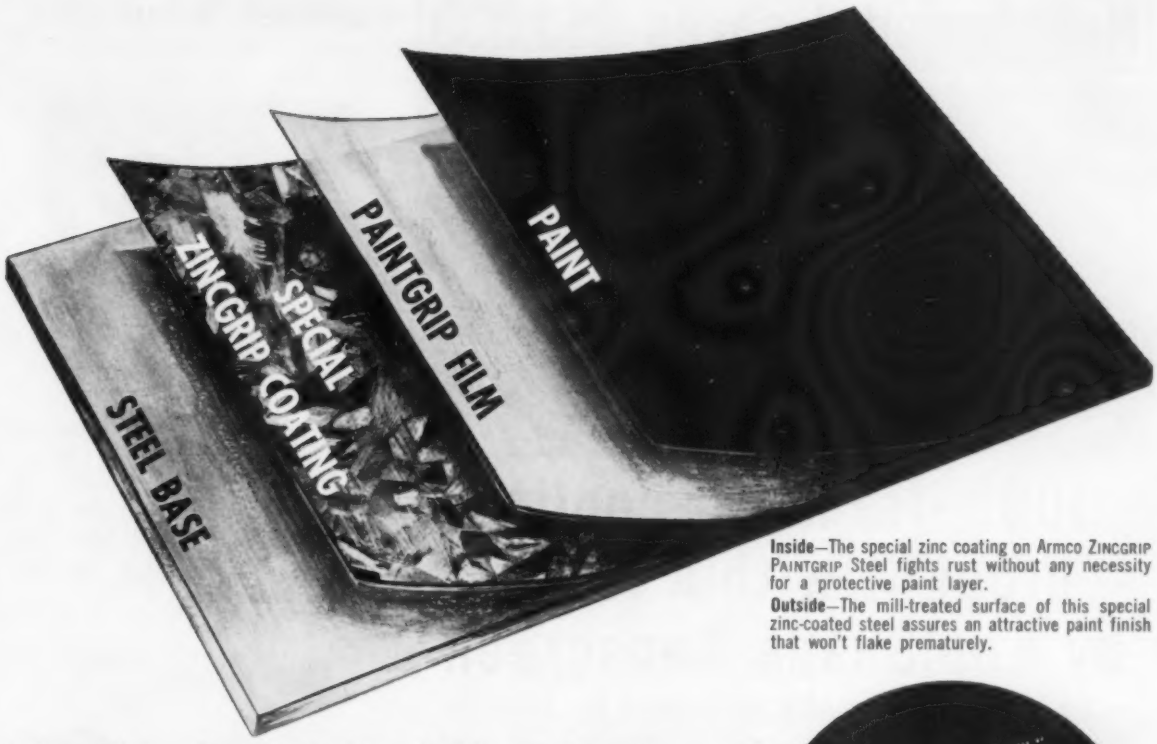


Template . . .

. . . of standard air conditioning, heating symbols—Rapidesign, Inc., P.O. Box 592, Glendale, Calif. Gives symbols derived from ASA Z 32.2.3 and ASA A 32.2.4. Made of .030 matte finish plastic, measures 7 × 5 in.

Coating . . .

. . . for fume ducts, hoods, etc.—Better Finishes & Coatings, Inc., 268 Doremus Ave., Nerwark 5. "Liquid Envelope 35-6587" applied with regular paint spraying equipment. Formulated to resist acids, alkalis, soot, moisture, fume laden air. Is said not to rupture under expansion, contraction conditions.



Inside—The special zinc coating on Armco ZINCGRIP PAINTGRIP Steel fights rust without any necessity for a protective paint layer.

Outside—The mill-treated surface of this special zinc-coated steel assures an attractive paint finish that won't flake prematurely.

Why This Special Steel Gives Ducts

Extra Protection

Here's why Armco ZINCGRIP PAINTGRIP Steel assures longer maintenance-free service for exposed ductwork in your heating and air conditioning installations:

Its mill-Bonderized surface holds paint much longer than untreated steel. And underneath the paint is a special zinc coating that gives unbroken rust protection.

This double rust protection for your heating and air conditioning ducts means more satisfied customers—longer service without replacement and costly maintenance. You can be sure there will be no premature flaking and peeling of paint.

You'll find this special steel is ideal in high quality casings too.

Let us send you more information about Armco ZINCGRIP PAINTGRIP. You can obtain this special steel from your nearby Armco Distributor.

This scratch test demonstrates ZINCGRIP PAINTGRIP's tight hold on paint. Paint on the untreated half of the panel flakes readily, while the paint on the ZINCGRIP PAINTGRIP half holds fast.

ARMCO STEEL CORPORATION
1375 Curtis Street, Middletown, Ohio
Send me more information on ZINCGRIP PAINTGRIP

NAME_____

COMPANY_____

STREET_____

CITY_____ ZONE___ STATE_____

ARMCO STEEL CORPORATION 1375 CURTIS ST., MIDDLETOWN, OHIO

SPECIAL STEELS

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

New hospital saves $50,300

100%-fresh-air cooling brought within reach by KoolShade Sunscreen

—7,430 ft. of screening cuts load by 74 tons!

Of the many features of Memorial Hospital, Savannah, Ga., none is more outstanding than its unusual air conditioning. It is primarily a 100%-fresh-air system!

Clearly superior to recirculating systems, 100%-fresh-air cooling has one problem: it requires far greater refrigeration tonnage. Hence it was economically imperative that Memorial seek out every practical means of reducing the load.

KoolShade Sunscreen — applied on south, east and west windows — was chosen immediately . . . and no wonder!

By controlling the solar heat transmission through glass, KoolShade actually reduced tonnage requirements by 74 tons! (Comparison: 2 inches of wall insulation was "worth" 72 tons.) Dollar savings, over and above the installed cost of the Koolshade, amounted to an estimated $50,300! And of course the building will continue to benefit from the lowered operation and maintenance costs.

Thus another great building proves it pays to *investigate* KoolShade Sunscreen!

Only Koolshade Sunscreen offers

- **unsurpassed shading efficiency**—keeps up to 87% of the sun's rays off windows during the hottest parts of the day: frees air conditioning systems from "hot spot" over-loads, gives relief from heat and glare, protects furnishings from sun-fading.
- **84% clear visibility**—better than with ordinary insect screening.
- **harmony with all architecture**
- **excellent insect protection**—no other screens needed on open windows.
- **virtually no maintenance**—strong metal fabric fully weatherized . . . never needs paint . . . lasts for years . . . withstands hard blows.

Send today

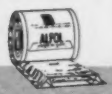
for this detailed and illustrated bulletin. And for expert help in cutting costs and sun problems, just request a call from a KoolShade engineer. No obligation or charge.

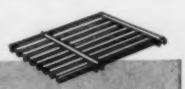
Distributor franchises still open in many communities for those who qualify.

118-55

KOOLSHADE Sunscreen BW

REFLECTAL CORPORATION
A subsidiary of Borg-Warner Corp.
310 S. Michigan Ave., Suite 2871,
Chicago 4, Ill.

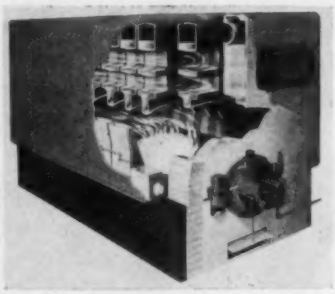




ALFOL INSULATION INGERSOLL ROOF DECK

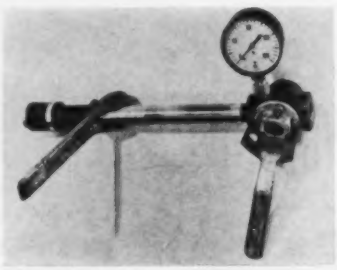
EQUIPMENT DEVELOPMENTS

Continued



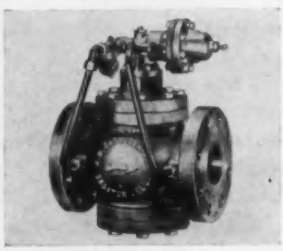
Boiler . . .

. . for use with horizontal rotary oil burners—Weil-McLain Co., Michigan City, Ind. With capacities to 12,270 sq ft steam, 19,630 sq ft water. Has special steel front plate and section designed to simplify burner installation.



Pipe Tester . . .

. . . with lubricated plug valve—Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8. For use in water works to test air or water pressure in light wall steel pipe, copper tubing. Test plug is inserted at each end of pipe. Gage indicates pressure loss, meaning leak in pipe.



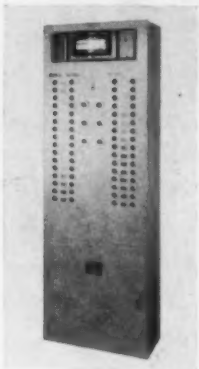
Control Valve . . .

. . . with self contained, single seat, pilot operated design—A. W. Cash Co., P.O. Box 551, Decatur, Ill. With adjustable throttling range. Features conversion from pressure reducing,

EQUIPMENT DEVELOPMENTS

Continued

regulating to back pressure control by switching control piping. Has dial type range selector. For use with water, gas, air, light oils, refrigerants.



Control Center . . .

. . . for automatically checking multiple temperatures in process work—Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill. Designed around "Multronic Capacitrol," pilot lights, pulse actuated stepping switch, pulsing timer, holding relays. Checks temperature at 32 stations in 2 min, says company.

Hose Clamps . . .

. . . designed for quick application—Circle Clamp Corp., 39 Broadway, New York 6. Fixed in place with ordinary pincers. Show no slippage, loss of clamping action at 12,800 psi hose burst pressure, says company. In 20 sizes ¼ to 2⅝ in. ID. Of various ferrous, nonferrous metals.

Magnetic Starter . . .

. . . for air conditioning, refrigeration—Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30. De-

MECHANICAL SEAL permanently seals against shaft leakage. *No expensive time or material required to service these pumps.*

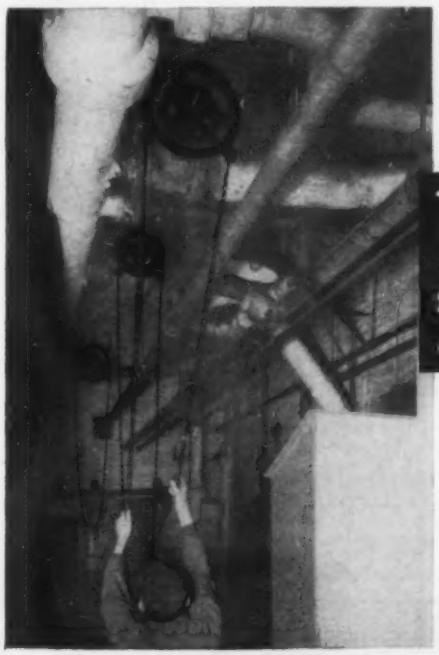
FRAME BEARINGS ARE GREASED FOR LIFE and *positively sealed against dirt and water.*

Trouble-free and maintenance-free, CARVER PUMPS are "*Your Best Buy for Better Performance.*"

Write for complete information today.

CARVER PUMP CO., 1460 Hershey Ave., Muscatine, Iowa

CARVER *The quality name in pumps*



Every Valve Easily Accessible with

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

NEWLY REDESIGNED for greater strength—easier, quicker, more solid assembly.

- **Simplifies pipe layouts**
- **Fits any size valve wheel**
- **Prevents accidents**

Your supplier carries complete stocks. Call him — or write for details and prices.

Babbitt STEAM SPECIALTY CO.

8 BABBITT SQUARE, NEW BEDFORD, MASSACHUSETTS, U. S. A.

To AIR CONDITIONING ENGINEERS,
Howell suggests

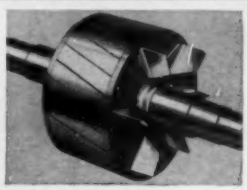
What to look for

in Part-Winding Motors

If you've investigated reduced voltage starting of compressors, centrifugal pumps, etc. with part winding (synchronous) motors, you know of the economies and efficiency to be gained.* But, as in other types of motors, manufacturers' constructions differ considerably. Below are some points for comparison . . . and a few of many reasons why Howell motors are so outstanding!

VENTILATION . . . "Cool running" means long life in motors. The steel shell of a Howell motor and a new stator design with the largest air passages yet devised put ample ventilation where it's needed. Compare!

BEARINGS . . . They should be fully protected. Dirt can't enter Howell's double shielded bearings either from inside or outside the motor, because they are sealed in the end plate cavities by dust-tight inner caps. Compare!



COPPER-CLAD ROTORS . . . Howell motors have copper-wound rotors. This means better heat conductivity, stability at high temperatures and, as opposed to die-cast rotors, greater design flexibility to meet your special requirements. Compare!

**Part winding motors reduce starting shock to machine, minimize line disturbances, and offer the advantages of low cost 2- or 3-step starters. A Howell motor specialist will be glad to show you their advantages (and limitations).*

WRITE FOR BULLETIN PM-1

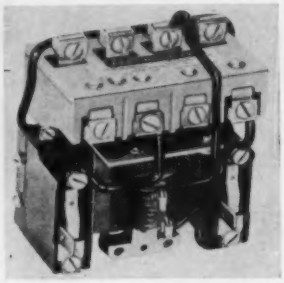
Precision-Built Motors for Industry Since 1915

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

EQUIPMENT DEVELOPMENTS

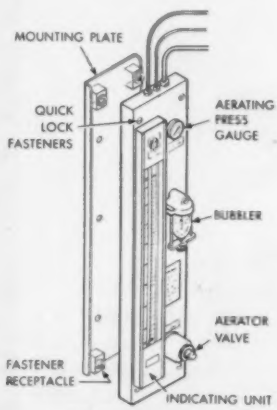
Continued



signed for control of hermetic motors. In two ratings: 20 amp continuous with 120 amp locked rotor current, 30 amp with 180 amp locked rotor current. Open or in NEMA 1 enclosures.

Power Pressure Burners . . .

. . . in oil, gas, combination gas-oil types—Ray Oil Burner Co., 1301 San Jose Ave., San Francisco 12. Modifications available to fire against positive firebox pressures to ¾ in. WC. Ratings to 2,500,000 Btu input with no secondary auxiliary air needed, says company.



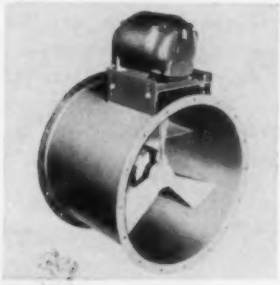
MODEL 1400B

Liquid Depth Gages . . .

. . . for storage tanks, process vessels in chemical, petroleum, paint, food, other industries—Liquidepth Indicators, Inc., 43-22 10th St., Long Island City 1, N.Y. In four models. Designed for easy installation, operation. Can be installed on tanks to 50 ft deep. Operate on hydrostatic pressure principle.

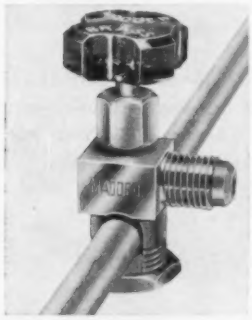
EQUIPMENT DEVELOPMENTS

Continued



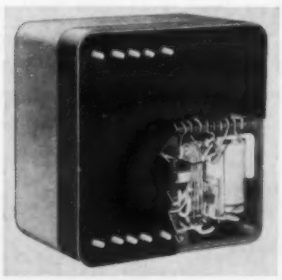
Propeller Fans . . .

. . . for handling corrosive exhaust, high temperatures, explosive fumes, other difficult air moving applications —Propellair Div. of Robbins & Myers, Inc., Springfield, Ohio. Belt driven tubeaxial type. In five sizes 16 to 36 in. Delivery ratings to 36,000 cfm.



Hermetic Port Valve . . .

. . . for testing, charging, purging—Madden Brass Products Co., Aurora, Ill. One valve pierces 3/16, 1/4, 5/16, 3/8 in. tubing, says company. Cited features: tightening nut designed not to score, collapse tube; tube automatically centered; normal wrench torque will not strip threads.



Electronic Circuit . . .

. . . added to burner controls—Minneapolis-Honeywell Regulator Co.,

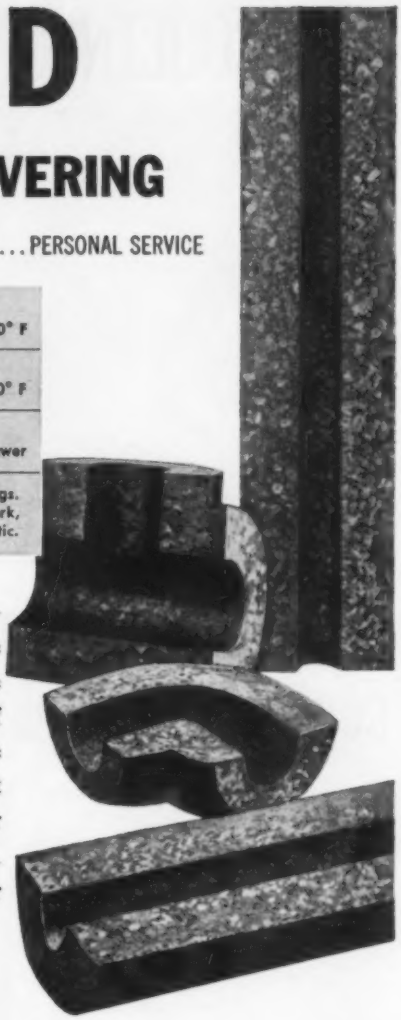
UNITED

CORK PIPE COVERING

LARGER STOCKS . . . FASTER DELIVERY . . . PERSONAL SERVICE

Light Duty Thickness (Ice Water)	to 30° F
Medium Duty Thickness (Brine and Ammonia)	to 0° F
Heavy Duty Thickness (Heavy Brine)	to —25° F or lower

For all standard pipe sizes and fittings. Molded of compressed pure granulated cork, finished with moisture-proof mineral mastic.



United Cork Companies have expanded their facilities to include the production of cork pipe covering. Increased quantities of most frequently used sizes are now available at key points coast to coast . . . in either distributor or branch warehouse stocks . . . thus insuring fast delivery of your installation requirements.

CORK . . . STILL UNSURPASSED AS A COLD LINE INSULATOR

- Extremely low thermal conductivity
- Saves at least 80% of refrigeration lost from bare piping
- Easily economically applied
- Permanent and durable, lowest long-term cost
- Does not support combustion
- Neat, sanitary, vermin-proof
- Has no capillarity

YOUR INQUIRY will bring you specifications, helpful installation data, descriptive material on United's cork pipe covering . . . and patented BB (block-baked) 100% Corkboard specially processed for low temperature work. No obligation.

UNITED BB CORKBOARD

SEE OUR CATALOG IN SWEET'S

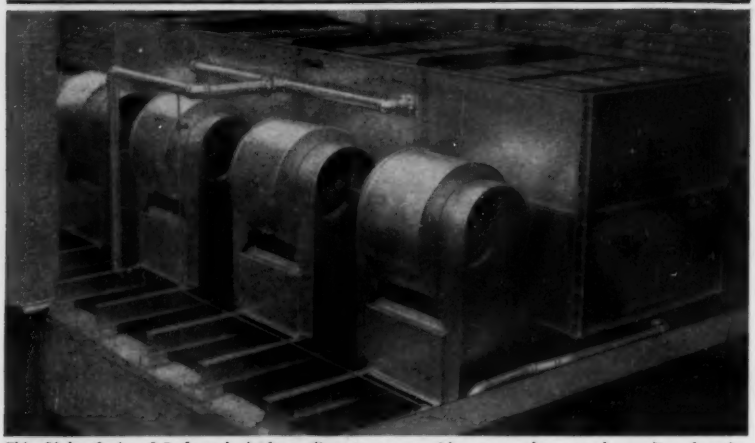
UNITED CORK COMPANIES

1 CENTRAL AVE., KEARNY, NEW JERSEY

Manufacturers of cork insulation for almost a half century

Engineering offices, or approved distributors, in key cities — coast to coast.

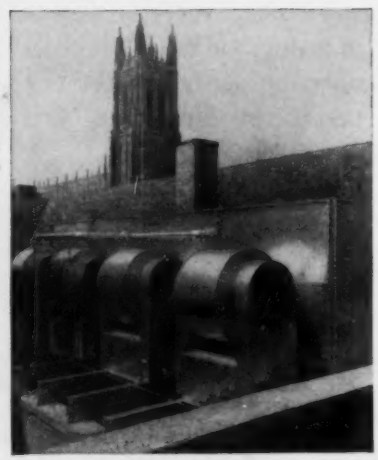
COOLING TOWER NEWS



This Binks Series 3-B forced draft cooling tower provides more than ample cooling for the 160 tons of air conditioning needed for this university chapel...and does it extremely quietly.

Quietness and compactness win contract for Binks Cooling Tower

Leading Southern University picks Series 3-B Tower for chapel roof.



The compact design and low silhouette of this tower keeps it out of sight from street level.

These modern forced draft, low silhouette, cooling towers featuring the dry blower air propulsion system, are designed for use where high cooling efficiency is demanded, combined with whisper-quiet performance and compactness. Squirrel cage blowers supply ample air movement at tip speeds far less than noisy propeller-type fans.

High cooling efficiency is obtained due to thorough water break-up from Binks patented Rotojet nozzles, combined with internal redwood nailless decking. They also feature counter-current operation with air movement in opposite direction to water flow.

Heavily galvanized, these towers reduce maintenance to a minimum. Interior surfaces are fully sprayed with a tough mastic coating. The air propulsion assembly is located in the dry air stream to protect it from corrosion. Series 3-B towers are completely shop fabricated, ready for easy assembly.

FOR FULL INFORMATION about Binks complete line of natural and mechanical draft cooling towers, write direct to the address below. Binks engineers will gladly help you select the right tower for your specific needs.

Binks
EVERYTHING FOR WATER COOLING

136-55

A COMPLETE LINE OF NATURAL DRAFT AND MECHANICAL DRAFT COOLING TOWERS AND INDUSTRIAL SPRAY NOZZLES

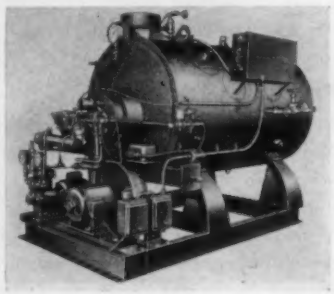
Binks Manufacturing Company
3118-38 Carroll Ave., Chicago 12, Ill.

REPRESENTATIVES IN PRINCIPAL U.S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

EQUIPMENT DEVELOPMENTS

Continued

Wayne and Windrim Sts., Philadelphia 44. Is incorporated in company's electronic "Protectorelay" unit. Features fast flame sensing, adaptability to commercial gas, oil, or combination burners.



50 Hp Boiler . . .

. . . designed to burn No. 4 oil—Cyclotherm Div., National-U.S. Radiator Corp., Oswego 5, N. Y. Makes possible to cut fuel costs, operates at 80 percent efficiency or better, says company. Requires less space than standard 50 hp units.

Sewage Ejector . . .

. . . submersible with 3 in. discharge —Weil Pump Co., 1523 N. Fremont St., Chicago 22. Is heavy duty screenless type with clog-resistant bladeless impeller. With motor ratings ½, ¾, 1 hp; capacities to 150 gpm.

Equipment Briefs . . .

SEMI-HERMETIC COMPRESSOR with five year warranty plan—Brunner Co., Gainesville, Ga. Under program, wholesalers will stock replacement parts and act as parts depots. Plan covers entire line.

EQUIPMENT DEVELOPMENTS

Continued

CASEMENT WINDOW AIR CONDITIONERS in ½ and ¾ hp models—Radio Corp. of America, 30 Rockefeller Plaza, New York 20. Kit available so unit can be installed in double hung windows.

POTENTIOMETER designed for high speed recording—Bristol Co., Waterbury, Conn. Features full scale pen travel in 0.4 sec. For recording rapidly changing variables.

ALUMINUM TUBING for specialty applications—Harvey Aluminum, 19200 S. Western Ave., Torrance, Calif. Designed for high strength, corrosion resistance. Cited applications: water heaters, gas engines, condensers, heaters, pumps, etc.

STEAM TRAPS with bucket type design—Clark Mfg. Co., 1830 E. 38th St., Cleveland 14. Line includes four models with "Duo-Step" leverage said to increase capacity without increasing body size. For pressures to 250 psi, temperatures to 450 F.

SOCKETLESS FITTINGS, HOSE KITS redesigned to replace cardboard kits—Aeroquip Corp., Jackson, Mich. Steel construction. Contain assortment including several new fittings, adaptors. Feature hinged top, removable compartment tray.

STEEL SCAFFOLDING designed to eliminate cross bracing, small assembly fasteners and parts—Swiss Fabricating, Inc., Camp Horne Rd., Emsworth, Pittsburgh 2. For simplified installation in industrial locations congested with piping.

ELECTRIC COMPRESSOR CLUTCH designed to solve automobile air conditioning problems—Warner Electric Brake & Clutch Co., Beloit, Wis. Permits motorist to start and stop refrigerating compressor clutch by manual or thermostatic control.

GAS-FIRED UNIT HEATERS

by Modine

give you ALL these advantages

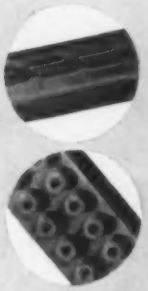
• No other manufacturer offers you rust- and corrosion-resistant stainless steel burners as standard equipment . . . plus a choice of aluminized or stainless steel heat exchangers. And there are many other features for reduction of overall costs. In many instances, for example, the savings a Modine Unit Heater allows in installation costs alone offset any difference in price.

WEIGHT COMPARISON

Brand	Capacity (Btu/hr. input)	Approx. Net Weight
Modine (aluminized steel)	105,000	105
Modine (stainless steel)	105,000	95
Brand "A"	100,000	170
Brand "B"	102,000	196
Brand "C"	90,000	175
Brand "D"	100,000	165
Brand "E"	100,000	210
Brand "F"	100,000	210
Brand "G"	105,000	170

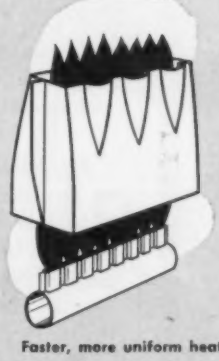
Lower shipping, installation costs

Light weight, without sacrifice of strength or efficiency, makes Modine Unit Heaters easier to handle, faster to install. Also cuts need for expensive support structures.



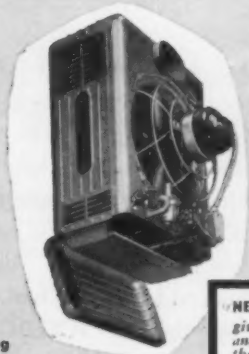
No port clogging, cleaner burning

Self-cleaning Modine burner ports have four times the free area of conventional drilled ports. Knife-sharp edges prevent lodging of scale.



Faster, more uniform heating

Continuous flame from front to rear of individually fired exchangers, increases radiant heat absorption, uniformly distributes heat through tube.



Easy access for inspection or service

Hinged casing swings down, reveals burners, manifold and pilot light. Complete burner assembly may be removed as a unit.

NEW 12-PAGE BULLETIN 655

gives you complete selection and application data. Call the Modine representative listed in your classified phone book. Or write Modine Mfg. Co., 1509 DeKoven Ave., Racine, Wisconsin.

GU-1269

Modine UNIT HEATERS

It's Terrific . . .

the NEW

TOLEDO

SPIN TORQUE CHUCK

The Perfected Chuck-Locks Tight with a

Spin of the handwheel!

● No more rocking, socking or hammering with the new "TOLEDO" SPIN TORQUE CHUCK. Now you can chuck ⅛" to 2" pipe, or rod as small as ¼", with a spin of the handwheel. Jaws are flush with chuck—exclusive rocking wedge action of jaws prevents slipping—husky "big hand" grip on wheel is easier to tighten — no end thrust slippage. See them at your pipe tool suppliers, now. Next time try "TOLEDO".

THE TOLEDO PIPE THREADING MACHINE COMPANY
1445 SUMMIT ST., TOLEDO 4, OHIO

BUILDERS OF THE WORLD'S FINEST PIPE TOOLS

TOLEDO®

PIPE THREADERS • PIPE WRENCHES • PIPE MACHINES

EQUIPMENT DEVELOPMENTS *Continued*

LINE LOADING VOLTMETER for installation technicians—Hickok Electrical Instrument Co., 10670 Dupont Ave., Cleveland 8. Lightweight, portable design. Plugs into standard 115 volt electrical outlet.

TEFLON-CERAMIC SEAL for company's line of positive displacement pumps—Eco Engineering Co., 12 New York Ave., Newark. Designed to broaden applicability beyond conventional Teflon-asbestos packings. For suction pressures as low as 29 in., discharge pressures to 100 psig.

VIBRATION MOUNTINGS for medium, heavyweight machinery—T. R. Finn & Co., Inc., Industrial Div., Hawthorne, N. J. Called "Floating Pillow," is rubber-in-shear type. Load capacities range 500 to 2500 lb per mounting.

AIR CONDITIONER designed to cool 430 sq ft, fit any type window—Hotpoint Co., 5600 Taylor St., Chicago 44. Is ¾ hp, pushbutton type.

HYDROMATIC VALVE for ion exchange water softener and demineralizer equipment—Cochrane Corp., Philadelphia 32. Is said to provide control of operating steps during regeneration. Value operates hydraulically.

PORTABLE DETECTOR for combustible gases, vapors—Johnson-Williams, Inc., 2715 Park Blvd., Palo Alto, Calif. Is portable type with switch arrangement designed to lengthen battery life. New type flame arresting system permits use of softer aspirator bulb to speed sampling.

ROOM AIR CONDITIONER with flush mounted limed oak face, adjustable louvers—Automatic Firing Corp., 4417 Oleatha, St. Louis. In ¾, 1 and 1½ ton models, with capacities to 18,000 Btu.

THERMISTOR RADIOMETER for measuring relative or absolute temperature—Williamson Development Co., 317 Main St., West Concord, Mass. Permits readings from surfaces of operating equipment, building walls, liquids, etc. Available in battery powered model for portable field use.

CONTROL VALVES in solenoid, pilot operated types—Airmatic Valve, Inc., Cleveland. Recommended by company for machine applications where continuous operation, compact piping needed.

COOLING-HEATING UNIT for motels, small buildings—A. Brown Products Corp., Forest Hills, N. Y. Works on one pipe forced hot water system. Has compact size for space economy. Is three row coil type.

EQUIPMENT DEVELOPMENTS

Continued

CIRCUIT BREAKER for use in panelboards, load centers—Trumbull Components Dept., General Electric Co., Plainville, Conn. Two pole, common trip type. In six ratings 10 to 50 amp for 120/240 volt a-c operation. Has 5000 amp a-c interrupting rating.

FILTER for smoke, smog—Radex Corp., 2076 Elston Ave., Chicago. Activated carbon type. Effective in public places, says company. For larger buildings, special installation with series of units can be obtained.

BUSHING for compressor-condenser units—Maurey Mfg. Corp., 2919 S. Wabash Ave., Chicago 16. Designed to provide more flexibility in cooling unit, save on pulley replacement. Used with 1, 2, 3 groove combination A and B groove pulleys for applications 10 to 16 in. diameter.

VALVE LUBRICANT for wide field of applications, broad temperature range—Meter and Valve Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8. Replaces four other lubricants in company's line. For temperatures —40 to 500 F.

PROTECTIVE COATING formulated to guard surfaces against moisture, oils, chemical fume and splash, etc.—Chemical Coatings & Engineering Co., Broomall, Pa. "Corrocote No. 362" is neoprene base compound. Applied by roller, brush, spray or dip; dries to form rubbery barrier.

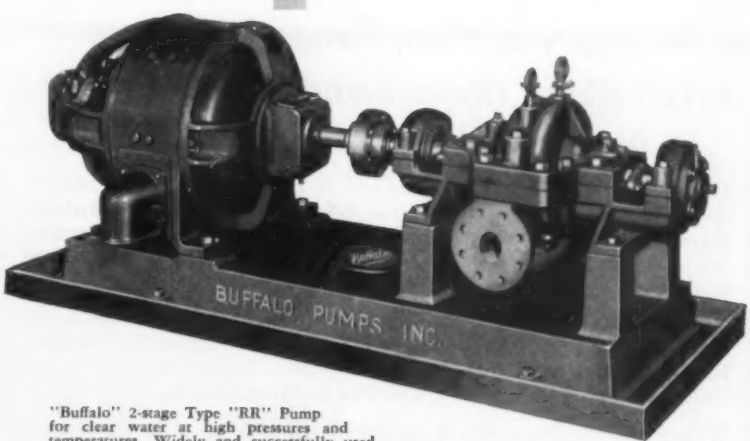
UNION SHANK HOSE COUPLING for handling petroleum products under pressure—Universal Valve Co., Elizabeth, N. J. Also, can be used with any liquid where suction or discharge involved. Has replacement pin lug or hex swivel nut and cast-in flange. In 2 and 3 in. sizes.

You're Actually Buying Low-Cost G.P.M.'s!

Put your pump buying on a basis of *overall costs,* for a true picture of what's the best buy! You're actually buying *delivered gallons,* over the life of the pump. How long the pump lasts—how efficient it is—how much it costs to maintain—are all factors that figure in your cost per delivered gallon.

Users of "Buffalo" Type "RR" Multistage Pumps have continued to enjoy low-cost gpm's, millions of gallons after installation. This is because of their inherent high efficiency, (which keeps your driving power requirements to a minimum) and simple, oversize construction (which keeps maintenance costs rock-bottom)—the "Q" Factor* which has been engineered into every "Buffalo" product for the past 78 years. It will pay you to write for Bulletin 980 and see why an "RR" is bound to give you low-cost gpm's in the long run!

NOTE: The "Buffalo" Pumps line is complete! There's a design for almost any liquid you may handle, under a wide range of hydraulic conditions. Let us know your problem—we'll mail you literature on the right pumps!



"Buffalo" 2-stage Type "RR" Pump for clear water at high pressures and temperatures. Widely and successfully used on boiler feed for many years. 2 and 4 stage models to deliver up to 900 gpm at heads as high as 1500'. Bulletin 980.

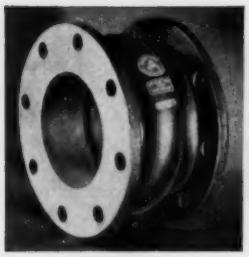
"Buffalo" PUMPS

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

BUFFALO PUMPS, INC.

171 Mortimer St., Buffalo, N. Y.
SUBSIDIARY OF BUFFALO FORGE COMPANY
Canada Pumps, Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID



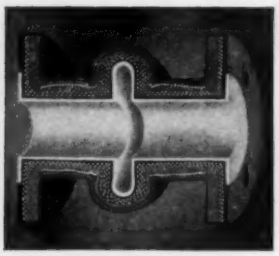
Spool-type
Rubber Expansion Joint

Rectangular-type
Rubber Expansion Joint

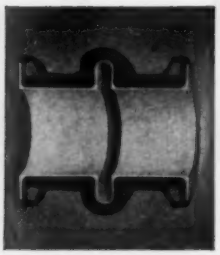
U-type
Rubber Expansion Joint

There's a GARLOCK EXPANSION JOINT for your piping applications

All-Teflon* Expansion Joint



Rubber Expansion Joint with Teflon liner



Expansion Joint for use on Haveg and Duriron piping

- **To stop vibration, flange breakage**
- **To relieve stresses and strains in piping and equipment**

Garlock manufactures a *complete* line of expansion joints specifically designed to meet the requirements of different types of service. **Rubber Expansion Joints** are made in all pipe sizes from ¾" to 72" for water, air, or exhaust steam. They are furnished in round, rectangular, tapered or offset; spool-type and U-type.

All "Teflon" Joints or **Rubber Joints with Teflon liner** are made for chemical service; **Neoprene Joints** for oil service. Specially designed Rubber Expansion Joints are now available for use on piping and flanges made by **Haveg Corp.** and **The Duriron Co., Inc.**

Write today for Expansion Joint Folder AD-137.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo Chicago • Cincinnati • Cleveland • Denver • Detroit • Houston Los Angeles • New Orleans • New York City • Palmyra (N.Y.) Philadelphia • Pittsburgh • Portland (Oregon) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

*The Du Pont Company's Trademark

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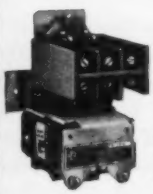
PACKINGS, GASKETS, OIL SEALS, MECHANICAL SEALS, RUBBER EXPANSION JOINTS

FURNAS ELECTRIC CONTROLS do the best job for AIR CONDITIONING

Objectionable voltage drops eliminated by using a Furnas Electric Increment Starter for Part Winding motor applications. Compare—no expensive auto transformers, no resistors, small size. Increment starting incorporates the advantages of other types of step starting at the lowest cost in the smallest space. Pick the size you need. In-between sizes—a 10, 20*, 30, 40* and 60 hp. size 220 volts.

*Major savings with in-between sizes.

SPECIAL STARTERS AND CONTACTORS



Designed for low cost control of hermetic motors. Two sizes — 20 and 30 amps • Dual voltage starter coils • Interchangeable parts • Super Quick Trip Thermal Overload units.

Write for Bulletin #5410 for complete air conditioning control information. Furnas Electric Company, 1041 McKee Street, Batavia, Illinois.

FURNAS ELECTRIC COMPANY

BATAVIA ILLINOIS

Sales Representatives in all Principal Cities

RECENT TRADE LITERATURE...

▸ *ADJUSTABLE SPEED DRIVE*—New 8 page publication GEA-6234 details company's general purpose, full wave "Thy-mo-trol" adjustable speed drive. Features industrial applications. General Electric Co., Schenectady 5, N. Y.

▸ *AIR CONDITIONING*—Packaged air conditioning units with capacities to 25 tons covered in bulletin No. C-1100-B64. Lists applications in various fields. Worthington Corp., Harrison, N. J.

▸ *AIR CONDITIONING UNITS*—New 20 page bulletin No. 8127 covers central station, cabinet type air conditioning units. Describes three types for industrial, commercial applications. American Blower Corp., Detroit 32.

▸ *ALUMINUM SHEET*—Wall chart gives weight, bend data on aluminum sheet in standard alloys. Is divided into three tables providing pertinent data for various gages, alloys, tempers. Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif.

▸ *BOILERS*—New 12 page booklet on package steam generators is compilation of articles that appeared in company's house organ, *Cyclotherm Sales Steam*. Describes formulas behind all package steam generators. National-U.S. Radiator Corp., Oswego 3, N. Y.

▸ *CENTRIFUGAL PUMPS*—Bulletin 7720A details centrifugal pumps for air conditioning, booster pump service. Units rated ¼ to 1 hp, single and three phase, with capacities to 70 gpm, heads 20 to 85 ft, ¾ and 1 in. discharge. A. Y. McDonald Mfg. Co., Dubuque, Iowa.

▸ *CHECK VALVE*—Features, specifications, charts, illustrations of new "Streamflow" center guided check valve detailed in new 8 page catalog 162. Valve designed for silent, shockproof operation with minimum pressure loss. Miller Valve Co., Inc., P.O. Box 1255, Pittsburgh 30.

▸ *CONTROLS*—"Limitamp" high voltage motor control is subject of new bulletin GEA-6331. Publication outlines features, covers installation and reduced space requirements. General Electric Co., Schenectady 5, N.Y.

▸ *CURRENT LIMITING FUSES*—Bulletin GEA-6319 describes current limiting fuses rated 250 and 600 volts in sizes 6 to 200 amp for low voltage circuit applications such as fused safety switches and

REMOVE CONDENSATE WATER

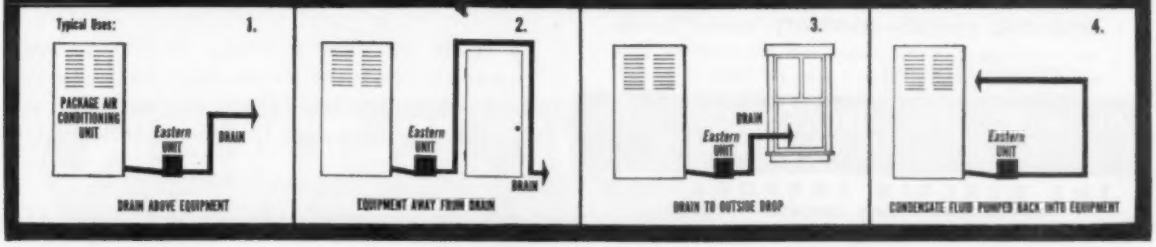
FROM AIR CONDITIONING SYSTEMS

A completely automatic, foolproof unit designed to remove hot or cold condensate fluids from the receiver tank and pump it to an outside drain. Simple to install with air conditioning equipment, it gives quiet and reliable performance.

Eastern Model 3, Type 100: Tank capacity 0.8 gallon. Centrifugal pump delivery approximately 4½ GPM at 0 P.S.I. and shut off of 12½ P.S.I. Motor 1/40 H.P., 115 volt. Weight 23 pounds. Mercury control switch. Size 5⅛ inches wide, 10 inches long, 11¾ inches high.

EASTERN INDUSTRIES, INCORPORATED

100 SKIFF STREET, HAMDEN, CONN.



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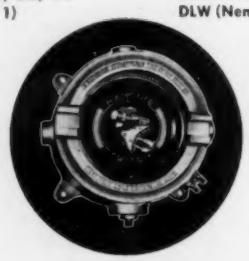
MERCURY SWITCH EQUIPPED
CONTROLS
TEMPERATURE
PRESSURE
LIQUID
LEVEL

Available for

Indoor-Outdoor
Hazardous Locations

FOR GENERAL PURPOSE
Series DA, DS, DR, DL
(Nema 1)

FOR OUTDOOR SERVICE
Series DAW, DSW, DRW,
DLW (Nema 1A, 2, 3, 4)



FOR HAZARDOUS LOCATIONS
Series DAE, DSE, DLE, DRE
(Class 1, Group D.)
(Class 2, Group E, F, G.)

OPERATING RANGES—SENSITIVITY: Mercoid Controls are available in many ranges with the sensitivity your application requires. Write for Catalog No. 7008

ALL MERCOID CONTROLS INCORPORATE SEALED MERCURY CONTACTS

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New York, 205 East 42nd Street • Philadelphia, 317 North Broad Street

RECENT TRADE LITERATURE

Continued

combination starters, small motor circuits. General Electric Co., Schenectady 5, N.Y.

▸ *DEAERATING HEATER*—Technical bulletin details small sized deaerating heater designed for use in small steam generating plants. Covers design, operation, application. Contains photographs, diagrams. Graver Water Conditioning Co., 216 W. 14th St., New York.

▸ *DEHUMIDIFICATION*—New bulletin covers dehumidifiction of compresesd air, gases using company's high pressure dehumidifiers. Refrigeration, adsorption types diagrammed. Desomatic Products, Inc., 1109 W. Broad St., Falls Church, Va.

▸ *DESURGER*—New 4 page data sheet details desurger designed to eliminate damaging surge, pump pulsation, water hammer shock. Cited applications are for reciprocating pumps, centrifugal and rotary pumps. Westinghouse Air Brake Co., Wilmerding, Pa.

▸ *DRAFT CONTROL*—Selection and specification of draft control in commercial, industrial sizes for gas, oil, coal fired heating equipment covered in new technical brochure. Field Control Div., Mendota, Ill.

▸ *DUST COLLECTOR*—Type "CW-1" centrifugal wet dust collector described in 4 page bulletin No. 919. Photographs, drawings, tables provide complete data. Pangborn Corp., Hagerstown, Md.

▸ *FILTERING COSTS*—Low cost of replaceable air filters and their influence on the economics of air filtration for central systems discussed in comparative study. Owens-Corning Fiberglas Corp., Toledo 1, Ohio.

▸ *FILTRATION—Get Perfect Water Clarity with Celite Filtration* is 12 page illustrated brochure covering filtration of potable water, process water, plant wastes. Johns-Manville, 22 E. 40th St., New York 16.

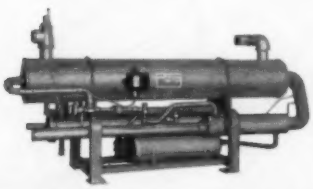
▸ *FITTINGS*—New hard bound catalog No. 55 covers company's complete line of steamless welding fittings, forged steel flanges, large diameter flanges, long welding necks, forged steel fittings. Illustrations, specifications given for each in volume's 304 pages. Ladish Co., Cudahy, Wis.

▸ *FLOW METERS*—Publication 55-1074-222 covers electronic flow meters for measuring differential pressures; liquid level; fluid, gas, air or steam flow; temperatures and pressures. Hays Corp., Michigan City, Ind.

▸ *FUSIBLE SERVICE ENTRANCE EQUIPMENT*—

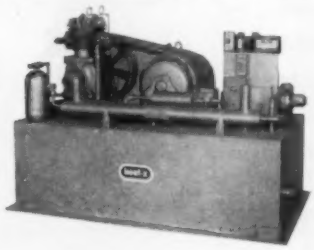
Heat-X 'PC' Units (above) provide the practical, space-saving answer to your water chilling needs . . . for air conditioning systems . . . drinking water or processing applications.

Inner-Fin construction of refrigerant passages, exclusive with Heat-X, permits a compactness impossible with old fashioned construction. Result: greater cooling capacity with far less bulk. Entirely self-contained, these *package* chillers are delivered completely wired, charged with Freon-12, ready to install. Only power and water connections are required. Available in 2 H.P. through 75 H.P. models.



'CCP' UNITS (right) are complete and ready to install, offer another method of packaged cooling. Combinations of cast aluminum coolers provide continuous chilled water, eliminate danger of freeze-up damage. Hermetic compressors carry 5 year warranty.

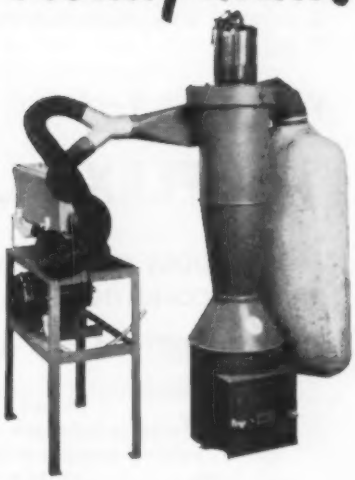
'PCL' UNITS (left) are designed for those who prefer a chiller to which they can tie in their own condensing unit and water pump. Construction is the same as the 'PC' line.



HEAT-X, Inc.
BREWSTER • NEW YORK

TORIT
DUST COLLECTORS

Really draw!



A size and model to solve any dust collecting problem, Torit collectors provide complete, all-around dust control. Torit collectors are unitized for custom installation on each machine, giving power and suction only when machine is operating. Keeps plant and machines free from clogging and unsightly dust. Furthermore, cleaned and filtered air is exhausted back *into* the room maintaining heat balance. Find out now how Torit unitized dust control is engineered to your problems.

See our catalog in Sweet's Machine Tool File, or write:

TORIT
MANUFACTURING CO.
283 Walnut Street • St. Paul 2, Minn.

RECENT TRADE LITERATURE *Continued*

Bulletin GEA-6286 explains features of seven basic fusible electric service entrance devices for commercial, light industrial applications, the home and farm. General Electric Co., Plainville, Conn.

▸ *GEARS*—New 76 page catalog G-655 contains illustrations, diagrams, definitions, tables, charts, explanations regarding gears in company's line. Presents method of calculating horsepower ratings of gearing. Philadelphia Gear Works, Inc., Erie Ave. and G St., Philadelphia 34.

▸ *HEATING, AIR CONDITIONING*—New 20 page brochure covers usage, description, design and product data for air filters, heat and sound insulation, reinforced plastic parts, gaskets. Owens-Corning Fiberglas Corp., Toledo 1.

▸ *HEATING, COOLING UNITS*—Bulletin HC-C2 gives capacities, dimensional data on remote type heating, air conditioning units. In models for floor mounted, semi-recessed, concealed installation. Fedders-Quigan Corp., Lalor and Hancock Sts., Trenton 7, N.J.

▸ *INDUSTRIAL TANK GAGES*—Information on operation, design of "Petrometer Series 1400" remote reading industrial liquid depth gages presented in 8 page bulletin 6004. Shows method for selecting right gage. Liquidepth Indicators, Inc., 43-22 10th St., Long Island City 1, N.Y.

▸ *LUBRICATED PLUG VALVES*—Reference book 39-5 shows straightway, three- and four-way and multiple port lubricated plug valves for 250 psi oil-water-gas, 150 psi steam. Homestead Valve Mfg. Co., Coraopolis, Pa.

▸ *MOTOR CONTROLS*—New 40 page publication EC-80 covers company's motor control line. Units broken down to include application and operation data, features, selection table. Controls are for air conditioning, heating and ventilating, pumps, compressors. Cutler-Hammer, Inc., 421 N. 12th St., Milwaukee 1.

▸ *OIL BURNERS—Tips to Successful Industrial Oil Burner Maintenance* outlines recommended maintenance and charting procedures for daily, weekly, semi-monthly, annual and occasional checks. H. Lieblich & Co., Inc., 36 W. 66th St., New York.

▸ *OIL SEAL*—New 28 page manual contains reference data, covers selection, application, installation of "Clipper" seals. Case histories discuss uses in

FOR FLEXIBLE CONNECTIONS IN

● DUST COLLECTION ● FUME CONTROL
● AIR-CONDITIONING ● MATERIALS HANDLING

PORTOVENT® ◂◂◂ USE ▸▸▸ FLEXAUST®

Spiral wire reinforced
DUCT

Sizes 3" to 36" ID Wide
Pitch type RETRACTABLE

Flexaust hoses and Portovent ducts are made with strong cotton or nylon fabrics, impregnated and coated with neoprene compounds. Seams are fully bonded. Other important features are—

- EXTREME FLEXIBILITY
- AIRTIGHT — STRONG
- LIGHTWEIGHT — DURABLE
- VERY EASY TO HANDLE AND INSTALL

STOCKS IN PRINCIPAL CITIES

Spiral wire reinforced
HOSE

Sizes 1¼" to 36" ID
Close pitch type

WRITE TODAY FOR
Bulletin #40 — General information
Bulletin #41 — Accessories and Installation Data
Bulletin #42 — Technical data on products and service.
Bulletin #43 — Application data and type selector guide.
Bulletin #44 — Friction loss data.
Prices lists.

THE FLEXAUST COMPANY, Dept. HP-8
100 PARK AVENUE NEW YORK 17, NEW YORK

Don't sit back

STRIKE BACK!

Give to
AMERICAN CANCER SOCIETY

"I shot an arrow into the air,
It fell to earth, I know not where."

The Arrow and the Song—Longfellow, 1845

Longfellow a space buyer?

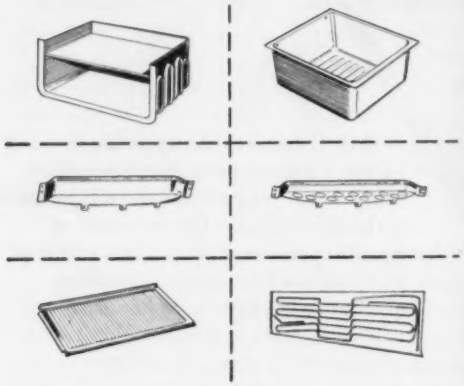
Longfellow's lament could well have been applied to advertising back in 1845. Yes, even up to 1914 when a group of advertisers, agencies and publishers, alarmed by the waste and guesswork in their business, brought order out of advertising chaos by organizing the Audit Bureau of Circulations. These pioneers in circulation auditing established a definition for paid circulation, rules and standards for measuring circulation, methods for auditing and reporting the FACTS. *For value-minded advertisers the era of blind space buying ended in 1914.* ☆ ☆ Today's experienced space buyers use the audited information in A.B.C. reports to aid them in applying media to markets and get full value for advertising dollars. Here are some of the FACTS in A.B.C. reports that provide a sound basis for advertising investments: • How much paid circulation • How much unpaid distribution • Occupational or business breakdown of subscribers • Where they are located • How much subscribers pay • Whether or not premiums are used • How many subscribers in arrears • What percentage of subscribers renew. ☆ ☆ Sales messages go direct to their targets, there's no shooting "into the air" when space buyers base their decisions on A.B.C. FACTS. This publication is a member of the Audit Bureau of Circulations because we want our advertisers to know what they get for their money when they use space in these pages. Ask for a copy of our A.B.C. report and then study it.

SEND THE RIGHT MESSAGE TO THE RIGHT PEOPLE

Paid subscriptions and renewals, as defined by A.B.C. standards, indicate an audience that has responded to a publication's editorial appeal. With the interests of readers thus identified, it becomes possible to reach specialized groups effectively with specialized advertising appeals.

A.B.C. REPORTS—FACTS AS A BASIC MEASURE OF ADVERTISING VALUE

Many Parts and Accessories are *BETTER* made of FAIRMONT ALUMINUM

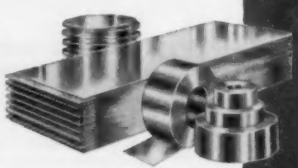


Refrigerator and freezer parts—pans, shelving, trays, evaporators, freezer liner panels—are increasingly being fabricated of Fairmont bright aluminum sheet to fulfill manufacturer's exacting requirements.

But there are other parts—too numerous to mention—that may now be better made of Fairmont aluminum, in improving appearance, high thermal conductivity, wear-resistant durability, and non-corrosive and stain-proof surfaces.

The use of Fairmont aluminum, increasingly available in a wide variety of grades and sizes, also may afford reduced labor and manufacturer's handling costs.

Fairmont bright aluminum rolling mill products—sheet, coil and circles are now available for prompt delivery to meet manufacturing schedules.



SALES OFFICES:

Baltimore, Buffalo, Chicago, Cleveland, Denver, Fairmont, Indianapolis, Jackson (Michigan), Los Angeles, Minneapolis, New York City, Philadelphia, St. Louis, Schenectady, Seattle.

FAIRMONT ALUMINUM COMPANY

Fairmont, West Virginia

RECENT TRADE LITERATURE

Continued

petroleum, automotive, aviation, process, other industries. Johns-Manville, 22 E. 40th St., New York 16.

▸ *PIPE CUTTER*—Spring load asbestos-cement pipe cutter detailed on illustrated sheet. Includes parts and price list. Spring Load Mfg. Corp., 3610 First Ave., S., Seattle 4.

▸ *PIPE INSULATION*—Glass fiber white dual temperature pipe insulation described in 4 page brochure. Insulation is said to provide insulating efficiency, condensation protection at low temperatures or at alternating cycles of high and low temperatures. Owens-Corning Fiberglas Corp., Toledo 1.

▸ *PUMPS*—Bulletin H20-1 describes company's controlled volume pump model "H-20." Provides information on simplex and duplex models, capacities, pressures, construction materials, mounting dimensions. Milton Roy Co., 1300 E. Mermaid Ln., Philadelphia 18.

▸ *REFRIGERANTS*—Technical service bulletin 11.12A covers "Genetron" refrigerants for air conditioning, refrigeration. Includes fact folders on both types. Lists physical data, quality specifications. General Chemical Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6.

▸ *REFRIGERATION, AIR CONDITIONING*—Catalog R-655 illustrates company's refrigeration, air conditioning accessories. Features several new valves, swivel tees, charging lines, flare fittings. Madden Brass Products Co., Aurora, Ill.

▸ *SOFT SOLDER ALLOYS*—Bulletin contains charts, brief descriptions, suggested uses for company's soft solder alloys. Alpha Metals, Inc., 56 Water St., Jersey City 4.

▸ *SOUNDPROOF ROOMS*—Prefabricated "Quiet Rooms" covered in bulletin SP-21. Contains dimensional drawings, lists features. Units designed for offices in noisy areas. Industrial Acoustics Co., Inc., 341 Jackson Ave., New York 54.

▸ *STEEL*—Company's 85 current technical data sheets, booklets listed in 16 page pocket sized publication list. Stainless, electrical, tool and die steel, other high alloy specialties covered. Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22.

▸ *TUBING*—New 4 page folder contains charts listing yield points, ultimate stresses, elongation per-

RECENT TRADE LITERATURE *Continued*

centages by grade for company's normalized and drawn tubing. Nikoh Tube Co., 5000 S. Whipple St., Chicago 32.

▸ *V BELTS*—Company's line of "Mor-Grip" fractional horsepower and heavy duty multiple v belts described in new 24 page catalog. Each belt detailed as to construction, applications. Maurey Mfg. Corp., 2907-23 S. Wabash Ave., Chicago 16.

▸ *VALVE*—Information on type "345" high pressure reducing, regulating valve contained in new bulletin. Illustrations, specifications, cited applications included. A. W. Cash Co., P. O. Box 551, Decatur, Ill.

▸ *VALVES*—Monel and nickel corrosion-resistant valves described in 4 page illustrated bulletin No. 9. Discusses properties, lists applications. Includes cross-sectional illustrations of gate, globe, check-type valves. Alloy Steel Products Co., W. Elizabeth Ave., Linden, N. J.

▸ *VALVES*—Forms 1005 and 1006 cover iron body gate valves, union bonnet bronze gate valves, respectively. Features, illustrations, specifications given for both. Ohio Injector Co., Wadsworth, Ohio.

▸ *VALVES, DRIERS, FITTINGS*—New 24 page catalog R-5 gives sizes, application data for brass valves, driers, accessories, fittings for refrigeration, air conditioning application. Superior Valve & Fittings Co., 1509 W. Liberty Ave., Pittsburgh 26.

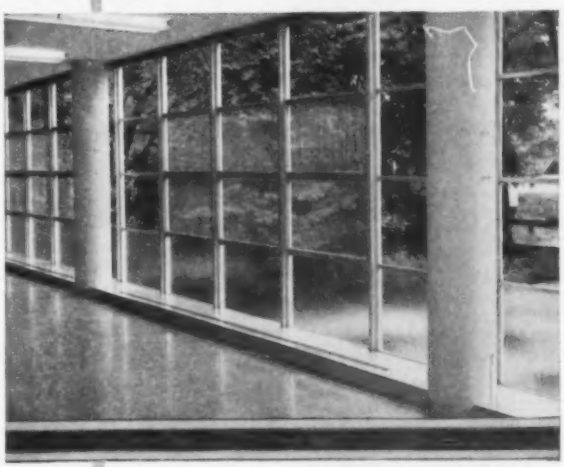
▸ *VALVES, FILTERS, DRIERS*—Folder stresses important role wholesaler plays in maintaining good will, lists company's authorized jobbers throughout U. S. A-P Controls Corp., 2450 N. 32nd St., Milwaukee.

▸ *VERTICAL MOTOR*—New 12 page bulletin GEA-6280 covers vertical "Tri-Clad" motor line ranging 7½ to 500 hp. Motor is shielded, hollow shaft, high thrust type. General Electric Co., Schenectady 5, N. Y.

▸ *WATER FILTERS*—Description of standard sized water filters for use with filter-aid designed to handle 8 to 939 gpm contained in release No. 214. Micro Metallic Corp., 30 Sea Cliff Ave., Glen Cove, N. Y.

▸ *WELDING*—Applications for company's "Low Heat Input" metal joining on base metals shown in new 4 page folder TIS 2496. Discusses procedures for many common metal joining jobs. Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing 58, N. Y.

Blend It...
Hide It...
Combine It...



Installed as a continuous strip in window head or sill (as above), AGITAIR STRIPLINE is the only practical means for air curtaining plate glass windows or wall areas to counteract summer heat or winter chill.

AGITAIR®
STRIPLINE
DIFFUSERS

BLEND IT . . . specify AGITAIR STRIPLINE as a continuous decorative unit, or in sections to meet any requirements of interior treatment.

HIDE IT . . . in shallow lighting coves for perfect concealment.

COMBINE IT . . . with unit or continuous lighting fixtures.

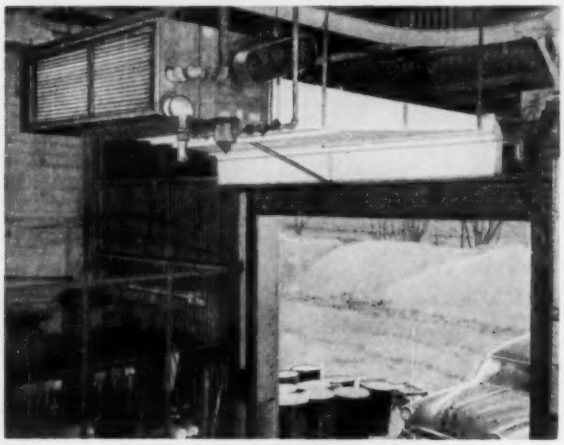
AND REMEMBER . . . no matter how you use it — AGITAIR STRIPLINE diffusing vanes create maximum mixing and aspiration . . . quick temperature equalization . . . and correct air distribution over any desired length.

Every Inch a Diffuser . . . the Vanes Make the Difference

AIR DEVICES INC.
185 MADISON AVENUE, NEW YORK 16, N. Y.
AIR DIFFUSERS • FILTERS • EXHAUSTERS

Carrier knows heating

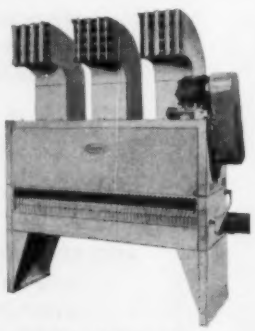
Over fifty years of leadership in air conditioning have given Carrier unmatched experience in the control of temperature—heating as well as cooling. Yes, Carrier knows heating by experience—and all this engineering skill and leadership contributes to the superiority of Carrier Unit Heaters.



Heat Diffuser used to "Air Blanket" Door Openings

This compact, versatile unit "blankets" door openings with a wall of warm air. Unique down-flow, warm-air outlet can be installed to extend across the top of the door. A full-width air blanket blasts warm air all the way to the floor. Unit can be thermostatically controlled to operate only while door is open. It keeps cold out, prevents drafts and saves fuel. It is ideal for open shipping doors. Sectionalized construction makes installation easy.

Carrier Heat Diffusers can be used for many other applications, industrial or commercial. They distribute heat evenly at full or partial loads. Positive control of heat saves fuel through flow control of steam or hot water, or damper control of air. Sectionalized construction permits floor mounting, vertical or horizontal suspension. Sizes and arrangements for 80,000 to 1,620,000 Btu/hr; 1500 to 31,000 cfm.



WRITE or USE COUPON for complete information

Carrier

air conditioning
refrigeration
industrial heating

CARRIER CORPORATION, 305 S. Geddes St., Syracuse, New York
Please send folders on features and selection data for Carrier Heating and Ventilating Units and Heat Diffusers.

*Name*_____

*Business*_____

*Address*_____

WHO'S WHAT...

▸ *JOHNSON SERVICE CO.*—Maxwell F. Rather, elected to the board of directors. Mr. Rather is vice president, district and export manager, and is located in New York. J. A. Cutler, president, R. J. Murphy, vice president and treasurer, A. J. Otto, vice president and works manager, and Mr. Rather constitute the executive committee.

▸ *WALWORTH CO.*—Newton Ewalt, chief engineer. Mr. Ewalt has been with Walworth since 1926.

▸ *AIR CONDITIONING BLOWER MANUFACTURERS' ASSN.*—Newly elected officers are: F. W. Brundage of The Brundage Co., president; Thompson Morrison of Morrison Products, Inc., vice president and publicity committee chairman; W. W. Morrisey of Lau Blower Co., secretary and treasurer. Publicity committee members: Ben Krause, Air Controls, Inc.; Bruce Epsteine, Lau Blower; Bob Main and Len Kroes of Brundage. Members of the engineering committee: W. A. Rockafield, chairman; John Burrows, Lau Blower; Norman Busch, Air Controls; Al Galaba, Morrison Products; Garry Baken, Viking Air Conditioning Corp. Tom Byrd, Lau Blower, and Ben Krause, Air Controls, were elected to the membership committee.

▸ *CARRIER CORP.*—Loren Fletcher, a vice president of the company. Mr. Fletcher, formerly general manager of the allied products division, will continue to manage engineering, production and sales for that department.

▸ *PENNSYLVANIA SALT MFG. CO.*—William P. Drake, president. Mr. Drake succeeds George B. Beitzel, who will continue with the company as a board member. At 42, Mr. Drake becomes the youngest president in the company's 105 year history.

▸ *AMERICAN SOCIETY FOR TESTING MATERIALS*—Claire H. Fellows, president. Mr. Fellows is director of the engineering laboratory and research department of the Detroit Edison Co.

▸ *RHEEM MFG. CO.*—William S. Rheem II, elected to the board of directors and named a vice president.

▸ *CORROSION RESEARCH COUNCIL of the ENGINEERING FOUNDATION*—H. H. Uhlig, head of the council's organizing committee. Mr. Uhlig is chief of the corrosion laboratory at Massachusetts Institute of Technology.

▸ *CORHILL CORP.*, Hoboken, N. J.—F. Carroll Stille, vice president. Mr. Stille was formerly manager of sales and also was executive vice president of Cornell & Underhill, Inc., Corhill's parent company.

#77 MOTEL
Beatrice, Nebraska

MOTEL DE VILLE
New Orleans, Louisiana

EL RANCHO MOTEL
El Paso, Texas

TALLY HO MOTEL
Valley Forge, Pennsylvania

The Swing's to Spotaire!

COX'S MOTEL
Fairfield, Illinois

BEDFORD MOTEL & INN
Bedford, Mass.

PYRAMIDS MOTEL
Las Vegas, Nevada

MEADOW ACRES MOTEL
Topeka, Kansas

drayer-hanson refrigerated
zone-controlled **AIR CONDITIONING**

Wilbur Clark's Desert Inn, at fabulous Las Vegas, sparked the trend to D-H Spotaire air conditioning. The Sands, The Thunderbird, The Flamingo, and others, soon followed suit. Now, hotel and motel owners and managers the country over—large and small, in "new" construction and "old"—acclaim the safe-'n-saving advantages of cooling and heating . . . ventilating and filtering . . . the Spotaire system way. Spotaire gives all-out performance. Its operation is service free. No expensive ductwork! No need to condition areas not in use! No compressor noises nearby—other mechanical equipment remotely placed! Just that breeze-easy Spotaire way of letting each guest be his own weatherman—and to his *exact* specification, by a mere flick of the switch.

SPOTAIRE HRC SERIES
Compact blower and coil unit for concealed, overhead, installation in each individual room.

SPOTAIRE VRC SERIES
Handsome console models, or recessed types, for individual-room installation.

A colorful brochure is yours, free. Write,

drayer-hanson INCORPORATED

3301 MEDFORD STREET, LOS ANGELES 63, CALIFORNIA
(SUBSIDIARY OF NATIONAL U.S. RADIATOR CORP.)

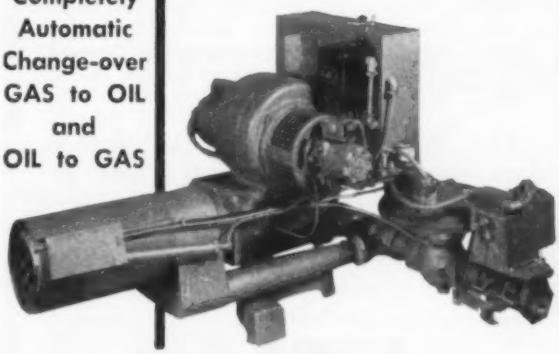
NEED STANDBY?

A COMBINATION

GAS OIL BURNER

WITH AUTOMATIC CHANGE-OVER

Completely Automatic Change-over GAS to OIL and OIL to GAS



Roberts-Gordon has done it again!

A completely automatic combination gas-oil burner — in three sizes! Oil capacity . . . 2½ gal. to 30 gal. . . . and available with modulating gas input . . . and 2-stage oil input.

It's compact — completely assembled and factory wired . . . and furnished with plug-in electronic controls for simple servicing!

Other ROBERTS-GORDON Industrial and Commercial Burners for Complete Heating and Processing . . .

MULTURI (Multiple Venturi) Burners
NORDENSSON POWER Burners

Write or phone for literature and details . . .

GAS HEATING EQUIPMENT
ROBERTS-GORDON
DEPT. HPAC BUFFALO 6, N. Y.
FURNACES BOILERS
UNIT HEATERS CONVERSION GAS BURNERS

WHO'S WHAT

Continued

▸ *CARRIER CORP.*—James C. Patterson, president of the General Alumni Society of the University of Pennsylvania.

▸ *JOSEPH T. RYERSON & SON, INC.*—Thomas E. Williams, general superintendent of the company's West Coast plants; Homer R. Brown, sales manager of the Milwaukee steel service plant.

▸ *PHILADELPHIA GEAR WORKS, INC.*—John R. Connolly, manager of the fluid agitator division.

▸ *TORK CLOCK CO., INC.*—Henry F. Zuba, a vice president; Dorset J. White, director of sales.

▸ *CORDO CHEMICAL CORP.*—George H. Sherrard, vice president.

▸ *CHASE BRASS & COPPER CO.*—J. Walter Gullicksen, vice president of the Waterbury Mfg. Co. Div.

▸ *DELAVAN MFG. CO.*—E. Vernon Jaramillo, a project engineer specializing in the design and development of liquid atomizing nozzles.

▸ *KERBY SAUNDERS, INC.*—Glenn O. Rusk, manager of the process and power division.

▸ *INTERNATIONAL NICKEL CO., INC.*—C. Roger Sutton, to the company's development and research division. Mr. Sutton has been senior metallurgist at the Argonne National Laboratory of the U. S. Atomic Energy Commission for the past five years.

▸ *REFRIGERATION ENGINEERING, INC.*—Sherman Singer, sales engineer.

▸ *VIKING AIR CONDITIONING DIV., NATIONAL-U. S. RADIATOR CORP.*—George J. Basl, product design engineer.

▸ *CRANE CO.*—Leo L. Daugherty, assistant treasurer; Warren A. Logelin, asistant director of public relations.

▸ *SERVEL, INC.*—Nelson W. Campbell, publicity manager.

▸ *FEDDERS-QUIGAN CORP.*—Harold S. Boxer, advertising and sales promotion manager.

▸ *YOUNGSTOWN SHEET & TUBE CO.*—Thomas G. Lewis, assistant to the director of purchases.

weil TVC LOW PRESSURE SYSTEM

Send for Bulletin TVC-300 E

Condensate Pumps

featuring
- LOW RETURN CONNECTION
- LOW SPEED — LONG LIFE
- CAST IRON RECEIVER
- LOW WATER LINE

Duplex Unit
25½" Diameter Receiver

Duplex units, with automatic alternators, furnish "extra" insurance, provide overload protection and guarantee an even longer life. Height of return above floor is 7 3/16".

Fig. No. 303 B

Single Unit
21" Diameter Receiver

Height of return is only 6⅞" above floor.

Single units of any rating can also be furnished in the 25½" diameter receiver. This receiver is furnished machined and drilled for the addition of another pump and control so as to enable conversion to a duplex unit at a later date.

Fig. No. 302 A

Capacities From
500 to 10,000 sq. ft. E.D.R.
Up to 30 lbs. discharge pressure

TVC Condensate Pumps are low speed (1750 RPM) for long life, are easily installed (two piping connections) in areas where space is important. The cast iron receiver and sturdy pumping unit (equipped with a dirt strainer), all completely factory assembled and tested, assure a long lived trouble-free installation.

Stocked by all leading jobbers

weil PUMP CO. 1514 N. FREMONT ST. • CHICAGO 22

You can have DRY AIR with exact moisture control..

Assembling Electronic Parts

FOR YOUR COMFORT

FOR YOUR PROCESS

FOR TESTING MACHINES OR MATERIALS AT ANY TIME OF THE YEAR

Packaging Food Products

● This Niagara "Controlled Humidity" method gives you the **MOST EFFECTIVE** Air Conditioning because its cooling and heating functions are made completely separate from adding or taking away moisture. This assures you always a precise result. No moisture sensitive instruments are needed.

Drying Industrial Material

MOST FLEXIBLE. You can reach and hold any condition in response to instrument settings, or vary it as you wish.

EASIEST TO TAKE CARE OF. The machine is accessible, the control circuits are simple and easy to operate, and there are no solids, salts or solutions to be handled.

MOST COMPACT. It does a very large amount of work in a small space.

INEXPENSIVE TO OPERATE. At normal atmospheric temperatures (unlike systems that use refrigeration to dehumidify) it needs no summer re-heat.

Write for Bulletins 112 and 122

NIAGARA BLOWER COMPANY

Dept. HP, 405 Lexington Ave. New York 17, N. Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

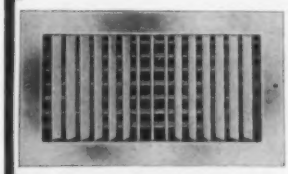
"GENERAL"

the name that stands for... **QUALITY** in air conditioning

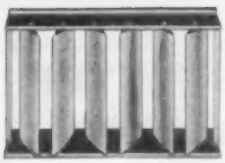
REGISTERS and GRILLES

Already acclaimed one of the leaders in the commercial grille field, the consistent quality of General products is bringing the name "preferred acceptance" across the country—with those who know.

G-R precision workmanship—and mass output—are the result of the finest in high-production facilities. Investigate the line that's—"Second to None."



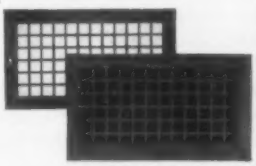
EVERYTHING STREAMLINED
General adjustable registers and grilles are streamlined throughout for appearance and operating efficiency, including fins, damper blades, and radius edges of the solid frame.



***Silentite* DAMPER**
Standard on General registers or furnished separately, the *Silentite* opposed-blade damper controls volume without turbulence. Reinforced hollow blades of great strength allows positive gripping of bearings for easy action without rattling.

Cross section shows streamlined contour.

"RANCH HOME"
Adjustable residential winter-summer heating-cooling model.



STAMPED GRILLES
Plain Lattice, Pencil-proof (schools), Sanitary (hospitals).

DUCTROL
Line includes air directors, mounting frames, fusible links, door grilles, various accessories, metals and finishes.

A Complete Line For Cooling and Ventilating

Write for Catalog On Your Letterhead

GENERAL REGISTER CORPORATION

14 Factory Street Cedar Grove, N. J.

For combustion testing in the field!

HAYS ORSAT TYPE GAS ANALYZER

The first of its type developed for field work, the Hays Analyzer answers the need for an Orsat type gas analyzer husky enough for use in the boiler room and for installation and service work in commercial and home heating plants, yet simple, fast and accurate!

It's Rugged—Made with strong pressed steel, the Hays Orsat is designed for continuous boiler room operation and field work . . . takes wear and tear in stride!

It's Portable—The Hays Orsat contains everything needed for *complete* analysis (CO_2, O_2, CO) in one light (only 8 lbs.), easy-to-carry case . . . goes wherever it's needed. Compact, with all parts easily accessible.

Available in one, two or three unit styles. Does a complete testing job for CO_2, O_2 and CO in 3 minutes!

Send for publication 54-668-27—a complete description of all styles.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Venturi Meters and Venturi
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 14, INDIANA

WHO'S WHAT

Continued

▸ *CLEAVER-BROOKS CO.*—Karl K. Hilgendorf, advertising manager.

▸ *COPELAND REFRIGERATION CORP.*—James E. Mason, assistant advertising manager.

IN THE TERRITORIES . . .

(Recent sales appointments)

▸ *FLEXONICS CORP.*—Bushnell Controls & Equipment Co., exclusive sales representative for expansion joints in the Los Angeles area; Joseph A. Schramm, a similar appointment for the St. Louis area.

▸ *WHEELCO INSTRUMENTS DIV., BARBER-COLMAN CO.*—W. J. Parker, transferred to the Cleveland office; Russell Roderick, to take over Mr. Parker's activities in the Rock Island, Ill. area. Other additions and their offices are: Frederick J. Haynes, Chicago; Gordon F. Best, Detroit; Philip Hercz, Cleveland. The Chicago office will be moved to new and expanded facilities in that city.

▸ *CARVER PUMP CO.*—Warren Ball, west central region manager covering Iowa, Missouri, Kansas, Nebraska, Minnesota, the Dakotas; Kenneth Adams, Jr., regional sales manager for Florida, Georgia, Alabama, Tennessee, the Carolinas.

▸ *DOLE REFRIGERATING CO.*—A. J. Lane, district manager of the Atlantic central area; Robert H. Tafel, to the Chicago sales staff.

▸ *U. S. AIR CONDITIONING CORP.*—Comfort Heating & Air Conditioning, distributor for the South Plains trading area.

▸ *J. F. PRITCHARD AND CO. OF CALIFORNIA*—C. J. Gaskell Co., Inc., sales representative for western Tennessee, southwestern Kentucky, northern Mississippi, northeastern Arkansas, southeastern Missouri.

▸ *BUSH MFG. CO.*—William K. Parks, sales engineer in the Chicago district; Richard Stewart, a similar post covering the northeastern part of Ohio.

▸ *HAMMEL-DAHL CO.*—MacGuire Instrument Co., sales and service representative for the Carolinas, part of Virginia.

▸ *AIRTEMP DIV., CHRYSLER CORP.*—Star Steel Supply Co. and The Burton Co., distributors in the Detroit area.

WHO'S WHAT — *Continued*

▸ *SARCO CO., INC.*—New sales representatives and their locales are: C.H. McGuiness Co., Des Moines; Steam Engineering Service Co., Denver; J.B. Lammons Co., Memphis; Robert Porter, Jackson, Miss.

▸ *DUNKIRK RADIATOR CORP.*—Oscar Mann Co., representative for eastern Pennsylvania, southern New Jersey.

▸ *CONNOR ENGINEERING CORP.*—Robert R. McKellar, New York district sales manager.

▸ *ECLIPSE FUEL ENGINEERING CO.*—E.L. Mountcastle, representative in North and South Carolina.

▸ *A. O. SMITH CORP.*—A. R. Schneller, eastern regional sales manager for the welding products division.

▸ *MARLO COIL CO.*—John B. Hewitt Co., Inc., representative in northern New Jersey.

▸ *MINNEAPOLIS-HONEYWELL REGULATOR CO.*—Stephen M. Ramsey, branch manager of the company's sales and service office in Miami.

▸ *STURTEVANT DIV., WESTINGHOUSE ELECTRIC CORP.*—Arco Electric Supply Co., Inc. and McCombs Supply Co., distributors for New York City and Denver, respectively.

▸ *SUPERIOR SUPPLY CO.*—G. L. Easley, to the company's sales staff.

▸ *SHAW-PERKINS MFG. CO.*—Harold E. Park, Pittsburgh sales representative.

▸ *MARSH INSTRUMENT CO.*—Earle L. Kneifel, sales representative in the Pittsburgh area to include all of southwestern Pennsylvania.

▸ *CHASE BRASS & COPPER CO.*—Louis F. Chol, district manager of the Newark warehouse and office.

▸ *BRUNNER MFG. CORP.*—H. M. Westerman, sales representative for southern and western New Jersey, eastern Pennsylvania, northern Delaware.

▸ *DELTA HEATING CORP.*—A. T. Gordon, New York district sales manager.

▸ *SERVEL, INC.*—Montefusco Heating and Sheet Metal Co., distributor for the Peoria, Ill. trading area; Isotherm Co., distributor for Kern County, Calif.

THERM-O-TILE
Reg. U.S. Pat. Off.
Underground Pipe Conduit

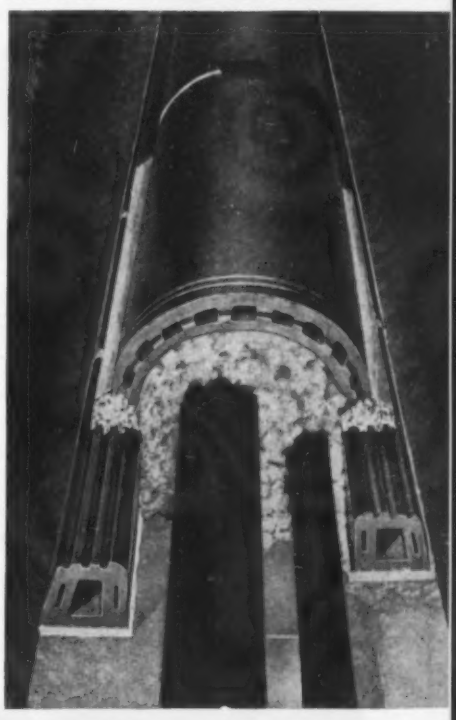
The top picture, at the right, shows a molded type insulation job, protected by Therm-O-Tile Conduit.

The bottom picture shows a filler type insulation job, protected by Therm-O-Tile Conduit.

These photographs appear in the new Therm-O-Tile Bulletin No. 10154.

ASK FOR A COPY

The bulletin is easily and quickly read. It covers all of the essentials pertaining to underground pipe conduit — supports, anchors, guides, sizes, strength, etc.



SEND A SKETCH

Send us a sketch of your contemplated underground pipe job, with principal data. Our engineers will gladly work with you. No obligation.

H. W. PORTER & CO., INC.
822-H Frelinghuysen Avenue • Newark 5, N. J.

REID HAYDEN, INC.
BALTIMORE, MD. RICHMOND, VA. CHARLOTTE, N. C.

Insulation Engineers & Contractors

WE HEAR THAT...

▸ A modern, single story building which will eventually encompass 500,000 sq ft of factory and office space has been started at Jackson, Mich., by *ACME INDUSTRIES, INC.* Ground was broken for the first unit in the expansion program in May, with completion scheduled for this fall.

▸ *CARL WEAVER* and *FRANK M. BENNETT* have sold all stock in the *REFRIGERATION ECONOMICS CO.* to *CARL HOWENSTINE AND ASSOC.*, who will continue only the wholesale refrigeration supply end of the business. *RECOY PRODUCTS CO.*, operated by Messrs. Weaver and Bennett at the original factory at Canton, Ohio, will continue the manufacture of "Recoy" products.

▸ *TRANE CO.* has opened its new 55,000 sq ft coil manufacturing plant. The second new manufacturing area to be put into operation by the company within a year, it consolidates all coil production operations into one location.

▸ *PITTSBURGH PLATE GLASS CO.* and *H. J. SOMERS, INC.* are now members of the *AIR FILTER INSTITUTE.* This brings the total roster of this organization of air filter manufacturers to 13 member companies.

▸ The *GALLAHER CO.* will expand its production by opening a new plant in Council Bluffs, Ia. The company said that all belt driven exhausters will continue to be produced in Millard, Neb., but that all production of direct drive exhausters will be shifted to the new plant.

▸ Climaxing a long and colorful career, *HARRY A. BURDORF*, vice president of the *LUNKENHEIMER CO.*, has retired. Mr. Burdorf joined the company in 1905 as a draftsman in the tool design department.

▸ *TYWEL MFG. CORP.*, makers of built-in wall air conditioners, has changed its name to the *LEWYT AIR-CONDITIONER CORP.*

▸ A campaign to support the products of manufacturers whose promotional activities recognize the importance of industrial distributors was launched recently in Atlantic City at a special meeting of the joint planning committee of the *NATIONAL* and the *SOUTHERN ASSOCIATIONS OF INDUSTRIAL DISTRIBUTORS.*

▸ *VAPOR HEATING CORP.* has purchased *INDUSTRIAL ENGINEERING CO.* Industrial Engineering

the smart money in
Las Vegas selected
International
the most practical air conditioning ever built!
THE STARDUST 1062 UNITS
THE MARDI GRAS
THE BALI HI
ROYAL NEVADA 254 UNITS
THE BADDIA 124 UNITS
MOULON ROUGE 113 UNITS
THE SAHARA 300 UNITS
THE DESERT WEST 32 UNITS
THE PECK 387 UNITS
Las Vegas wasn't the only place that the "smart money" picked International. In Houston it was the modern Park Towers apartments (765 units) . . . in Baltimore the Lloyd E. Mitchell Co. (2109 units) . . . in Baton Rouge two Pick Hotels, The King and The Heidelberg (465 units) . . . and in Chicago The Drake Hotel (600 units). Write or wire International for complete information and the location of an installation near you. See for yourself the excellence of construction and superior performance built into the sensationally quiet International units.
Model CHW 90
Ceiling Hideaway
Console Hideaway Units Also Available
In All Standard Sizes
International
Air Conditioning Division
MANUFACTURING COMPANY
600 EAST GRAND AVENUE
OKLAHOMA CITY, OKLAHOMA
CABLE ADDRESS INTIME

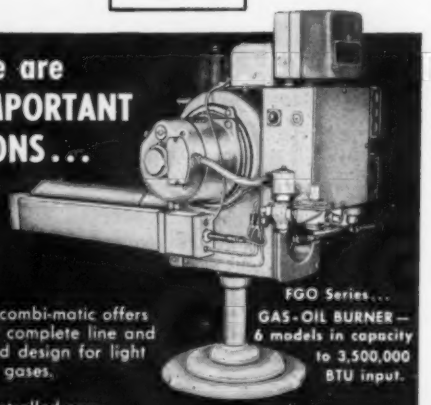
??? WHY... ???

Power Combi-Matic

Forced Draft GAS OIL Burners

Here are THREE IMPORTANT REASONS...

(and there are more)



FGO Series... GAS-OIL BURNER — 6 models in capacity to 3,500,000 BTU input.

1. POWER combi-matic offers the most complete line and advanced design for light oils and gases.
2. Now! controlled combustion on both gas and oil... with higher efficiency and lower operating costs.
3. Positive and complete *safety* with a *pre-purge* period in standard operating cycle.

MORE SALES FOR YOU... BECAUSE THERE ARE MORE ADVANTAGES FOR YOUR CUSTOMERS:

- Factory "FIRE-TESTING" insures... "on the job" performance.
- Automatic air adjustment... lets you set it—forget it.
- Electronic safeguard... responds immediately to flame interruption.
- Pressure safety control... prevents opening of either fuel valve unless air for combustion is proven.
- Optional automatic or manual changeover...
- GAS ELECTRIC IGNITION... is automatic on BOTH fuels.

SOMETHING EVERY DEALER WANTS:

- Less installation time.
- Standard parts and controls always and immediately accessible...

Power combi-matic Gas-Oil burners are but one important part of a complete line of burners.

FG Series—Power gun type burners—ideal for all conversion applications... particularly oil burner replacement.

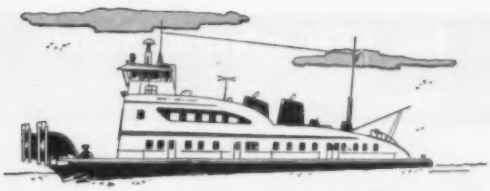
BFG Series—Heavy duty Power-Flame burners—large capacities for heating, power or processing.

A Power-Flame Dealership can be valuable; write today for complete information

Power-Flame BURNER

A Division of

Siemon Manufacturing Company • Grandview, Mo.



in *Shipbuilding* as in other great industries

MILLER WELDERS are preferred

Miller Selenium Rectifier type D.C. Arc Welders are available in four wide range models. For complete information on these and other Miller arc and spot welders, contact us today at no obligation, of course.

St. Louis Shipbuilding and Steel Co., largest builders of inland towboats in the world, require welds that will withstand a maximum amount of abuse.

Look anywhere in St. Louis Shipbuilding's mammoth yard and you will see Miller Selenium Rectifier type D.C. arc welders — in single units or in batteries of four and five for greater output.

For dependable welds, St. Louis Shipbuilding prefers the Miller S.R. welder. Miller is glad to be aboard.

ARC • SPOT miller GENERATORS WELDERS

miller

ELECTRIC MANUFACTURING CO., INC.

APPLETON, WISCONSIN

DISTRIBUTED IN CANADA BY

CANADIAN LIQUID AIR CO., LTD., MONTREAL, P.Q.

Two NEW industrial heaters that mean MORE CONTRACTS for you

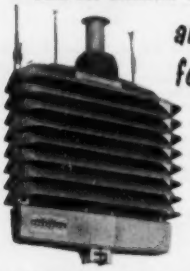
Easy to Install
Minimum Servicing
Automatic Operation

THERMOBLOC
DIRECT-FIRED HEATERS

The ideal warm air heater that heats large open buildings in all directions without ducts. Where necessary to heat individual rooms, THERMOBLOC is easily adaptable to ductwork.

THERMOBLOC is *fully* automatic and can be installed in a matter of hours. Available for either oil or gas, THERMOBLOCS are manufactured in nine models from 100,000 btu to 2,250,000 btu output. This means you can give your customers exactly what they need in heating capacity . . . fast!

Ask for Bulletin GC-4-55.



and "Bring the Sun Indoors" for your customers with...

PANELBLOC
GAS FIRED INFRA-RED UNIT HEATERS

Heats like the sun . . . with gentle, healthful rays. Requires no fan or motor . . . no electrical connections. Installation requires only support from ceiling and hooking up to fuel supply and vent. Unit burns any commercial type gas fuel. You can guarantee customers will keep warm even when power lines are down.

Infra-red rays radiate to the spot you want to heat. PANELBLOC heats only personnel and machines or other objects . . . not air.

Heat is not deflected by draft or wasted in the ceiling. No moving parts mean less maintenance. Available in two sizes, 62,500 btu and 125,000 btu input. Ask for Bulletin P-154.

You can please your customers and make more profits for your company by specifying THERMOBLOCS or PANELBLOCS, depending on the requirements of the installation. Contact Thermobloc Sales today.

THERMOBLOC
Division of
PRAT-DANIEL CORPORATION
5-8 Meadow St. • South Norwalk, Conn.

Prat-Daniel Corp.
South Norwalk, Conn.

Gentlemen:

I would like to know more about ☐ THERMOBLOCS ☐ PANELBLOCS

Name_____ Title_____

Company_____

Address_____

WE HEAR THAT

Continued

will be incorporated and operated as a division of Vapor with *HARRY J. JENSEN* vice president of the division.

▸ *FISHER GOVERNOR CO.* has acquired the assets of *THERMO INSTRUMENTS CO. D. M. COMB*, former president of Thermo is now associated with Fisher Governor in Marshalltown, Iowa

▸ Construction work on *PITTSBURGH PLATE GLASS CO.'s* plant at Cumberland, Md. is underway. Total cost of the ultra-modern plate glass producing facility is estimated at $34 million.

▸ *YORK CORP.* was honored as a 50 year member of the American Society for Testing Materials at the society's annual meeting held recently in Atlantic City. The award was accepted by *F. J. ALLEN*, assistant to the chief engineer of York's industrial division.

▸ The completion of expanded plant facilities and a broadened sales operation for the Multi-Vent Div. of the *PYLE-NATIONAL CO.* has been announced. *WILLIAM C. CROFT*, company president, pointed out that the expansion represents the culmination of 10 years of research and production planning.

▸ *PENNSYLVANIA SALT MFG. CO.* has moved its executive offices from the Widener Bldg. in Philadelphia to Three Penn Center Plaza in that city.

▸ An open house for customers of *WOLVERINE TUBE DIV. OF CALUMET & HELCA, INC.* marked the opening of new mill depot facilities and a branch office of the east central sales district in Detroit. The depot has 16,800 sq ft of floor area.

▸ *CARRIER CORP.* announces the formation of a new central planning division to coordinate all divisional and major departmental plans and to engage in long term planning for the company as a whole. The division will include the present planning staff and will be headed by *JOHN H. HOLTON*, a vice president.

▸ New warehousing facilities have been established in Atlanta by *SUPERIOR VALVE & FITTINGS CO.* The installation is set up to supply wholesalers in Georgia, Florida, North and South Carolina, Tennessee, Alabama and Mississippi.

▸ *SUPERIOR VALVE & FITTINGS* marked the tenth anniversary of the opening of its Chicago warehouse recently.

...this chemistry laboratory relies on long-lasting

TRANSITE INDUSTRIAL VENT PIPE

Here, in the chemistry laboratory of one of the nation's largest universities, Transite® Industrial Vent Pipe was specified for use in this fume hood installation because of its proven record of performance under severe conditions. It will provide long, trouble-free service without maintenance.

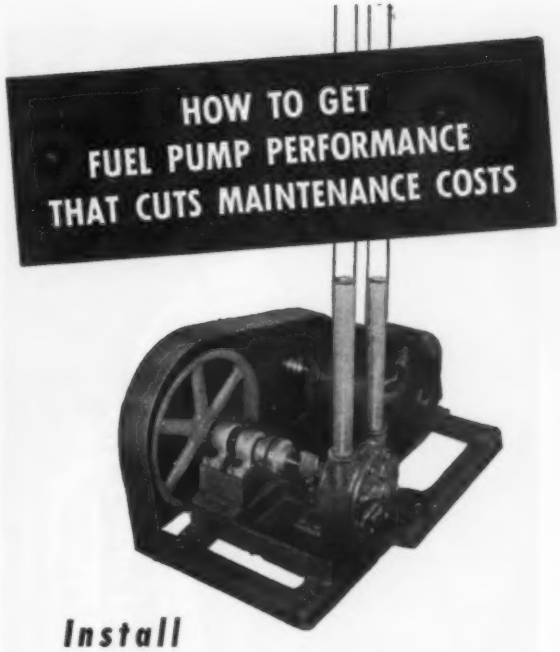
Made of two of nature's most indestructible minerals, asbestos and cement, Transite is highly resistant to the corrosive fumes, vapors and dusts that must so frequently be removed from research laboratories and industrial buildings. Whether installed indoors or outdoors, Transite never requires painting or other preservative coating.

Transite Industrial Vent Pipe offers other advantages, too. It is easy to install because it is light in weight and can be handled readily. No special equipment is needed for cutting on the job. A wide variety of fittings and pipe sizes make it adaptable to every industrial venting service.

For additional information about the use of Transite Industrial Vent Pipe for your venting problems, write to Johns-Manville, Box 60, New York 16, N.Y.

JOHNS-MANVILLE JM PRODUCTS

JOHNS-MANVILLE
TRANSITE INDUSTRIAL VENT PIPE
AN ASBESTOS-CEMENT PRODUCT



Install
TUTHILL TYPE SU *Pumping Units*
For Dependable Service in Industrial Heating

Tuthill Type SU multiple V-belt pumping units provide structural and performance advantages for dependable, uninterrupted operation that add up to reduced maintenance expense.

Features like these make the SU outstanding for handling heavy fuel oils in industrial heating:

- ★ **Motors up to 5 h.p. mounted on slotted slide rails for easy adjustment or replacement. No drilling or tapping required.**
- ★ **Cast iron base with mounting bolts and adjustments easily accessible.**
- ★ **One-point belt-tension adjustment.**
- ★ **Jack shaft, supported by ball-bearing pillow blocks, carries entire weight of pulley and absorbs belt tension.**
- ★ **Pump, jack shaft and pillow blocks available as separate unit.**
- ★ **Pump and jack shaft direct-connected by flexible coupling for better alignment and simplified mounting.**
- ★ **Wide range of pump models and capacities.**

Complete data is presented in Tuthill Catalog No. 107. Write for your copy today.

TUTHILL PUMPS FOR ANY PURPOSE

TUTHILL PUMP COMPANY
Dependable Pumps since 1927
939 East 95th St., Chicago 19, Illinois
Canadian Affiliate: Ingersoll Machine & Tool Co., Ltd.
Ingersoll, Ontario, Canada

WE HEAR THAT

Continued

▸ An open house was held recently at *BARBER-COLMAN CO.'s* new Park Plant which contains over 125,000 sq ft of manufacturing space and houses the company's Uni-Flo Air Distribution Div.

▸ *INTERNATIONAL NICKEL CO., INC.* has opened its Southeast States Technical Field Section with headquarters in Atlanta. Covering the Carolinas, Georgia, Florida and Alabama, the section will furnish technical information and assistance relating to nickel alloys.

▸ A modern three story factory building has been acquired by *CORY CORP.*, Chicago. The 32,000 sq ft structure is immediately adjacent to the company's main appliance plant in that city.

▸ Increased sales in the water and sewage field by *PENN INSTRUMENTS DIV., BURGESS-MANNING CO.* has led to the creation of a separate municipal division headed by *RICHARD A. McQUADE* with *FRANKLIN L. SOMMER* as regional sales manager.

▸ The "Aqua Heater" insulated tankless water heater and the variety of bent tubing produced by *JOSEPH E. LEWIS & CO.* were exhibited recently to the employees of the Baltimore Div. of *REVERE COPPER AND BRASS, INC.* The exhibit was one of a series of displays intended to inform Revere workers of the end-uses of the metals they fabricate.

▸ *B. F. GOODRICH* has awarded a contract to *THE GIRDLER CO.*, a division of *NATIONAL CYLINDER GAS CO.*, covering engineering and construction work to be undertaken in the expansion of Goodrich's Hycar synthetic facilities in Louisville.

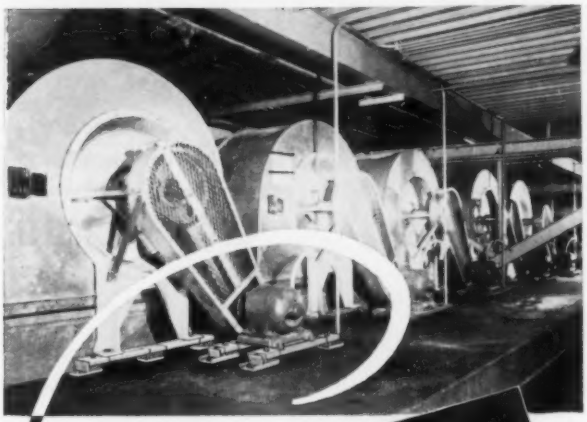
▸ *TUBE REDUCING CORP.*, producers of a tube reducing process for cold finished tubing, has announced plans to expand facilities for the manufacture of a special type cold finished tubing.

▸ *B-I-F INDUSTRIES, INC.* has increased sales and service facilities in the Midwest by opening new offices in Milwaukee and Indianapolis.

▸ *HAMER VALVES* sales representatives recently attended a four day sales meeting at the plant in Long Beach, Calif. Plans for 1955 and sales forecasts were discussed.

▸ A $10,000 endowment fund to establish the *W. C. Coleman Scholarship in Business Education* at Ottawa Univ., Ottawa, Kan., has been announced by the *COLEMAN CO.*

STOP VIBRATION



with **KORFUND VIBRATION CONTROL**

The photograph shows five of a total installation of 324 Clarage Heavy Duty Fans at The Upjohn Company's new pharmaceutical plant at Kalamazoo, Mich.

Korfund Twin Rail Bases under each fan and motor keep noise and vibration from reaching working areas through the steel deck or through the air conditioning ducts, and make possible this simple, space-saving installation on suspended platforms and structural steel members under the roof.

Korfund Duplex Twin Rail Bases have separate rails for fan and motor, and are completely adjustable—on the job—to take care of any drive center distance, motor position, bolt location or other variables. Built-in chocks assure positive alignment. Light weight, they are easier to handle. Base Drawings are immediately available for most fans and motors. And, because of standardization, long production runs reduce cost and permit quick deliveries.

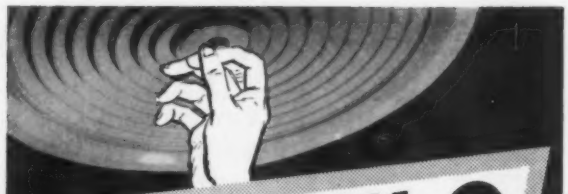
For installation of fans, pumps, compressors, refrigerating and other types of mechanical equipment for both normal and critical operating conditions, basic isolation recommendations are given in Bulletin No. 15. Write for your free copy today, or see our catalog in Sweet's Files. Write, too, for one of our free Belt-Center Distance Calculators—it's a real time saver.

If you have a specific problem, we will be glad to submit recommendations without obligation. A half century of experience is at your disposal. Representatives in principal cities.

THE KORFUND CO., INC.

KORFUND VIBRATION CONTROL — SPRINGS — RUBBER — CORK

48-01F Thirty Second Place, Long Island City 1, N. Y.
In Canada: 510 Canal Bank, Ville St. Pierre, Montreal

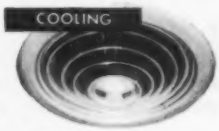


FLEXIFLO

The Diffuser for Every Application

Here's the complete diffuser line with all extra features: built-in equalizing deflectors; easy to install; quick adjustment of air volume and diffusion pattern; simplified engineering; beautifully finished in any color baked enamel.

Let our sales engineers show you why Flexiflo is better for your jobs. But first—get the Flexiflo catalog.

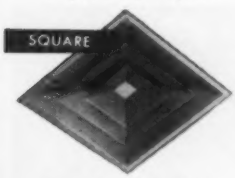


Type R, constant flow pattern regardless of volume adjustment.

Type V, fully adjustable air diffusion pattern and volume.

Type MP, for 1-, 2-, 3- or 4-way diffusion to accommodate any shaped area, 16 styles.

Type CH, adjustable for heating, ventilating and cooling.



Type H, adjustable volume, constant pattern and radius of diffusion.

Type S, side wall or ceiling, with Type R or V blades for heating or cooling.

Return this coupon

FLEXIFLO

UNIVERSAL DIFFUSER CORP.
1360 GARRISON AVE., NEW YORK 59, N.Y.

Please send me complete catalog HP

NAME_____

COMPANY_____

STREET_____

CITY_____ ZONE____ STATE_____

WE HEAR THAT

Continued

▸ A one week industrial instrumentation course, given periodically by *FISCHER & PORTER CO.*, has been completed by a group of nine technicians from various industries. The course includes a general orientation of the application of instrumentation to industry, the theory and calibration of the variable area flow meter, and the design, nomenclature, function, and maintenance of industrial control instrumentation.

▸ Production of a new 16 mm 17 minute sound color motion picture, "Compressed Air Power," is announced by the Educational Committee of *COMPRESSED AIR AND GAS INSTITUTE*, Cleveland.

▸ *WORTHINGTON CORP.'s* midwest regional engineering and service division, Chicago, has been moved to new and air conditioned quarters at 6124 N. Pulaski Rd. in that city. The Chicago district sales office will continue at 400 W. Madison St.

▸ Returned from a second tour of the northern California area, the *DAY & NIGHT DIV. OF CARRIER CORP.'s* "Road Show" had surpassed the 20,000 mile mark. Since January the specially designed staging has been set up and broken down for over 100 sales meetings across the country.

▸ *MRS. LOIS G. McDOWELL*, assistant professor of mechanical engineering at Illinois Institute of Technology, has been elected national president of the Society of Women Engineers for 1955-56.

▸ *HAROLD W. FAULKENDER*, president, *LAU BLOWER CO.*, recently presented a plaque paying tribute to the founders of the firm, *E. B.* and *MARION LAU*. The presentation was made on behalf of employees who have been with the firm over many years.

▸ A series of sales clinics appraising the expanded field of automation, introducing new control products, and including a study of marketing problems and quotas has been completed by *WHEELCO INSTRUMENTS DIV., BARBER-COLMAN CO.* All of the company's branch office personnel were in attendance.

▸ A two day seminar entitled "Opportunity" and devoted to "Trufin" integral finned condenser tube manufactured by *WOLVERINE TUBE DIV. OF CALUMET & HECLA, INC.* was held in Philadelphia recently.

▸ *THERMOBLOC DIV.* of *PRAT-DANIEL CORP.* held its annual sales meeting recently at South Norwalk, Conn. The meeting featured an exhibit of the company's "Thermobloc" and "Panelbloc" lines.

FARRAR & TREFTS
DIVISION
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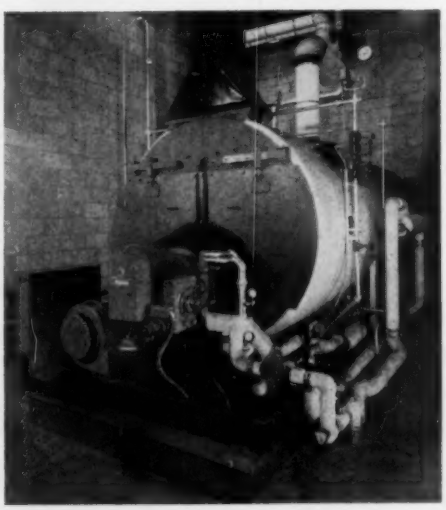

3000 Series Package Boiler Installation
Sears, Roebuck Co., Buffalo, N. Y.

Streamline Welded BISON BOILERS Streamline Welded

FOR HEAT and POWER

Designed to produce maximum steam output in shortest time at minimum operating costs.

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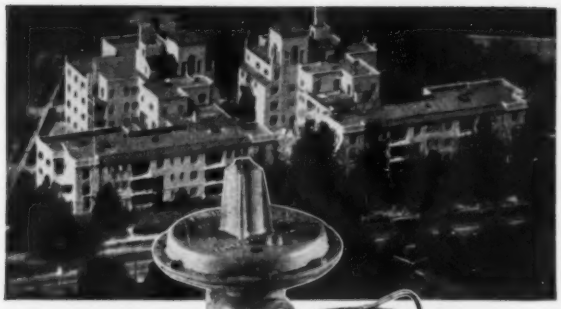


Lo-BLAST Burners heat this huge Cincinnati apartment building.

FOR EVERY TYPE OF BUILDING

LO-BLAST

IS THE LOW-COST WAY TO HEAT WITH GAS

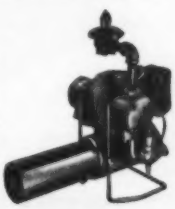
Every dollar trimmed from operating expense shows up on the profit side of the ledger. That's why fuel-saving Lo-BLAST Power Gas Conversion Burners are the sensible selection for buildings which must produce income . . . or for home owners concerned with keeping living costs down.

Lo-BLAST operating cost averages 10% less

The Lo-BLAST principle of combustion utilizes an extremely quiet, low speed blower to provide perfectly controlled primary and secondary air. Hence operation is always independent of natural draft conditions—makes the Lo-BLAST ideal for down-draft boilers. Combustion is completed in an incandescent firebox, with radiant heat applied to the crown sheet as well as side walls. There's no combustion roar—the flame is soft and *quiet!*

High efficiency on intermittent operation

Lo-BLAST Burners show only a small drop in over-all efficiency when changing from constant to intermittent operation. This is the reason for Lo-BLAST fuel economy, since intermittent operation is the normal condition for any heating plant.



Lo-BLAST Economite
Residential size—70,000 to 500,000 BTU—with all the fuel-saving features of the standard Lo-BLAST.

Factory-tested on gas, shipped completely assembled

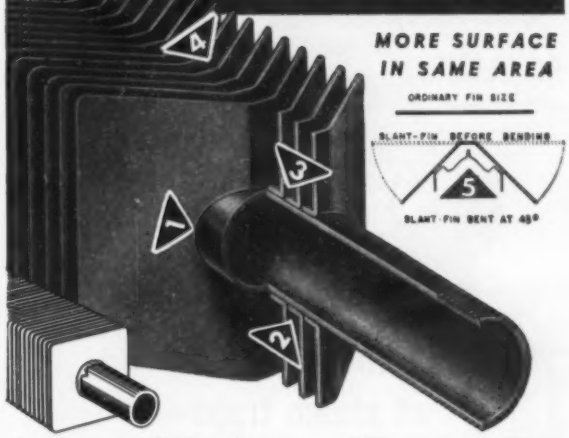
Installation and servicing are easy *because there's nothing in the firebox but the fire!* All units have standard controls with positive acting pilot and blower safetys.

Capacities from 70,000 to 20,000,000 BTU input. Write for engineering data.

MID-CONTINENT
METAL PRODUCTS CO.
1960 N. Clybourn Ave., Chicago 14, Ill.

SLANT-FIN

TELLS WHY THIS IS BETTER FINNED PIPE



Improved Design and Construction

IN BOTH "SLANT-FIN" AND "SQUARE-FIN" RADIATORS

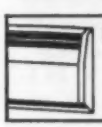
1 **BETTER FIT OF FIN TO PIPE.** With exclusive equipment designed by Slant-Fin engineers, pipe is forced through undersize hole in fins under tons of hydraulic pressure. No weakening of pipe walls by expanding pipe or by fins cutting into pipe surface. The result is the **strongest mechanical union of pipe and fin.**

2 **PERFECT THERMAL BONDING.** On a special machine, standard pipe is rolled to uniform, absolutely round diameter. Wide flanges of fins press solidly against entire surface of pipe for **highest heat transfer efficiency.**

3 **PRECISION SPACING AND EXTRA STRENGTH.** For the flanges of the fins, Slant-Fin devoted much time to experimental engineering. Because of the uniformity of the flanges and their interlocking features, the **fins fit tightly one into another.**

4 **MORE EFFICIENT AIR CIRCULATION.** Because of the increased surface, **fewer** of the distinctive "V" shaped **slant fins** than the traditional square fins can furnish the same radiation per linear foot of pipe. Therefore, fins can be wider apart and a greater volume of air flows more freely.

5 **NO SNAPPING — NO BUCKLING OF FINS.** Because of the **patented notched flange,** the slant-fin can expand and contract without disturbing the bond to the pipe, even under high steam pressures. The result is a radiator that is trouble-free and **noiseless.**



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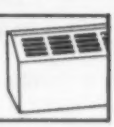
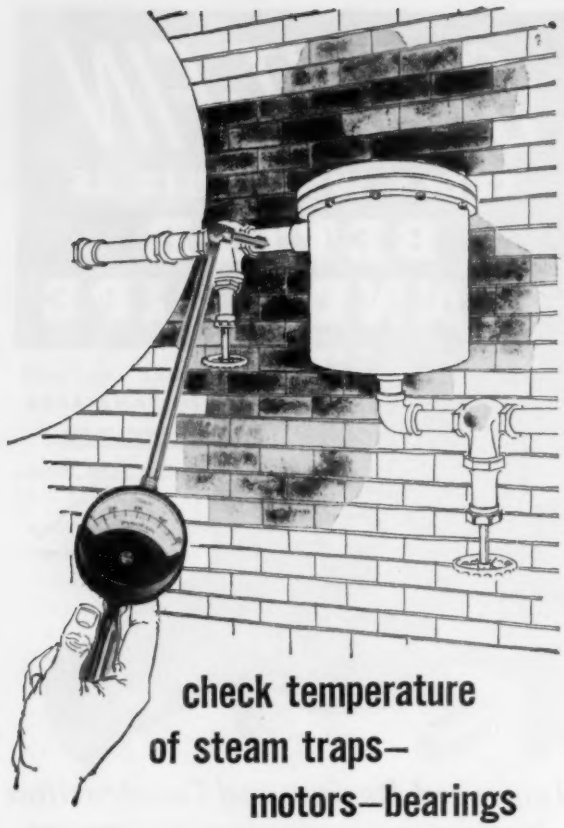
For Steam or Hot Water.
Choice of 3 Heating Elements and 2 Enclosure Styles.



CATALOG No. 505 gives details on the complete line of "Slant-Fin" and "Square-Fin" radiators and enclosures for commercial and industrial applications. BULLETIN No. R-602 supplies facts about residential baseboard heating. Write for your copy.

SLANT-FIN RADIATOR CORPORATION
87-65 130th Street, Richmond Hill 18, New York



check temperature of steam traps— motors—bearings

. . . quickly and accurately with the Alnor Pyrocon, the portable contact pyrometer for taking surface temperatures. This handy, portable instrument can be your most useful maintenance and installation tool . . . it provides accurate temperature readings instantly of any surface (metallic or non-metallic), flat, curved, stationary or revolving.

It's a well-balanced instrument mounted in a sturdy case for protection against the usual hazards of on-the-job service. Jeweled movement is also heavy-duty, shock-resistant type that will withstand hard and continuous use . . . performing with laboratory accuracy.

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Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

WE HEAR THAT

Continued

▸ Completion of a modern, one story building in Wethersfield, Conn. marks a step in the rapid growth of the six year old *CARLIN CO.* The building contains 13,300 sq ft of working and storage area—approximately two and one-half times the space of the former plant.

▸ *KATHABAR DIV.* of *SURFACE COMBUSTION CORP.* is holding a two week field application school for the sales organization at the University of Toledo. The program is under the chairmanship of *FRED M. JOHNSON*, sales manager.

▸ *TRANE CO.* has announced the completion of its first mid-year student training program. The five month course was scheduled twice this year to keep up with the demand for sales coverage brought about by expanding product lines.

Lack of Adequate Preventive Maintenance a Major Cause of Explosions

REGARDING THE ARTICLE, *How Efficient are Methods of Burning Heavy Oils?*, in the June HPAC, I would like to add my comments to those of Anthony Jelenc, of Ace Engineering Co., on proper preventive maintenance.

The lack of adequate preventive maintenance has been a major cause of many explosions that we have experienced in the past several years. Therefore, we feel that the subject of preventive maintenance cannot be over-emphasized.

The people who have been experiencing the bad explosions will not have to be persuaded of the benefits of a preventive maintenance program. And it is worth every effort to convince other people in industry as to the necessity for proper preventive maintenance so that we all may prevent as many disastrous explosions as we can.

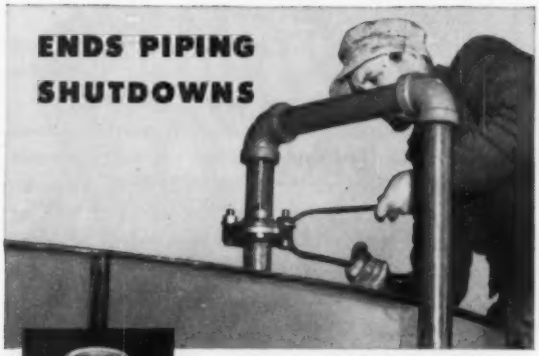
G. M. Woods
Special Engineer
Factory Insurance Association

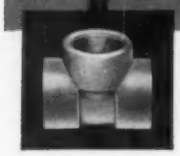
THE AUTHOR REPLIES—

Preventive Maintenance of Oil Burner Controls Would Cut Risks

I WOULD LIKE TO SUPPLEMENT G. W. Woods' comments on the article, *How Efficient Are Methods of Burning Heavy Oils?*, in the June HPAC.

I purposely neglected to mention preventive maintenance of burner controls in my discussion at the commercial-industrial panel for oil burning at the recent convention of the Oil-Heat Institute because of the short time allotted and since Carl Swanson of the Minneapolis-Honeywell Regulator Co. cov-





This PVC piping—with injection molded fittings—lasts and lasts

At this plant, unplasticized PVC piping handles sulfuric, nitric, muriatic, phosphoric, and acetic acids. Pressures range to 100 psi. This PVC piping, using Tube Turns Plastics' injection molded PVC fittings, has been in service for months, shows no signs of deterioration. Yet the metal and alloy metal piping it replaced failed at 3 to 12 months intervals from corrosive action. Cut your maintenance—eliminate shutdowns and hazards. Write for free booklet describing properties of unplasticized PVC fittings and flanges. Tube Turns Plastics, Inc., Dept. PC-8, 224 East Broadway, Louisville 1, Kentucky.

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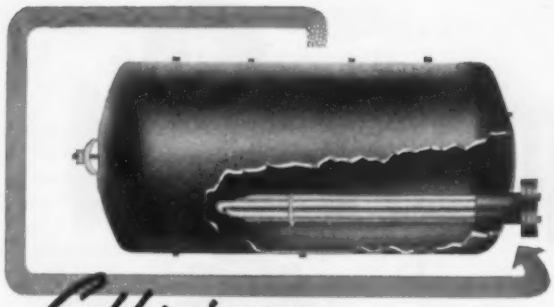

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Here is a Hot Water Generator that will give you the maximum in efficiency! *More* hot water at *less* operating cost. Quality of constructions is your assurance of the maximum operating efficiency from your FINNIGAN equipment. Adaptable to any type operation—built to your specification in capacities from 66 to 5,000 gallons, FINNIGAN Hot Water Generators are made from the finest material and contain copper removable-coil heating element. They are equipped with large size tappings which can be bushed to fit any job.

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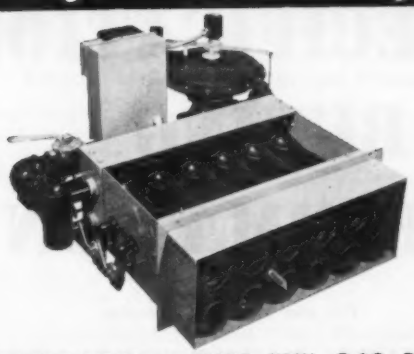

The HORIZONTAL or TYPE "H" GAS BURNER **for Scotch Marine or other type boiler where the "Inshot" type of firing is preferred. Multiple flame retention heads assembled in a heavy gauge housing with balanced air louvres and specifically designed pilots provide the maximum in flexibility and dependability. Complete prewiring and factory assembly of controls simplifies, and cuts hours from installation time.**

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Gordon & Piatt
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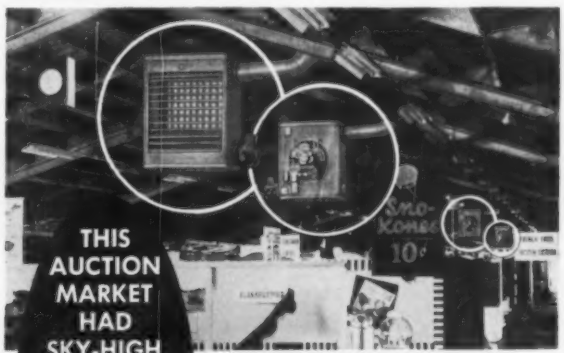
WINFIELD, KANSAS



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PROBLEM: Open only on weekends, this large, drafty farmer's auction market used abnormal quantities of fuel and still never warmed up sufficiently.

SOLUTION: 8 Delta oil-fired unit heaters were installed. They run on low cost #2 fuel oil and give immediate warm-up. Adjustable louvres direct heat where needed . . . without cold spots, overheating or heat wasted on walls or ceilings.

RESULTS: The market now is comfortably heated in an hour. Fuel bills have been cut almost 50%.

This is only one of hundreds of jobs that a Delta OIL Unit Heater can do better and more economically.

DELTA HEATING CORPORATION
TRENTON 8, NEW JERSEY

Install BUILDERS SHUNTFLO STEAM METERS right in your steam lines. Keep track of steam costs by seeing where steam is going and how much. Shuntflo Meters available in Model SMKS (shown) for 2" to 14" lines — Model SMDH for 1" and 1½" lines. Write for Shuntflo Bulletins. Builders-Providence, Inc. (Division of B-I-F Industries, Inc.), 381 Harris Ave., Providence 1, R. I.

BUILDERS-PROVIDENCE
DIVISION OF B-I-F INDUSTRIES, INC.
METERS FEEDERS CONTROLS

ered the subject of these controls.

However, I would like to add here the following comment to the portion of my topic, "Preventive Maintenance in the Prevention of Explosions:"

There are several fine combustion control systems available that are approved by various insurance underwriters. None of these control systems, however, protects a burner system from the effect of leaking solenoid gas and oil valves. These valves may be held partially open by debris lodging in the valve seats.

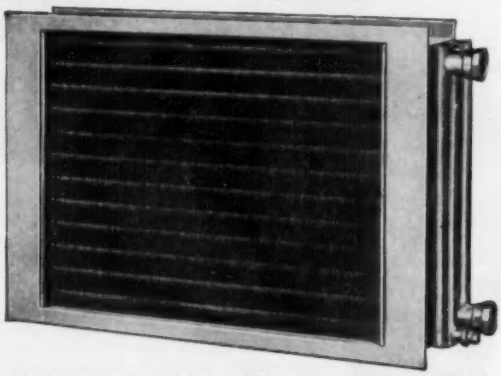
During the off cycle of the burner the ever present possibility of gas or oil leaking into the combustion chamber is a potential hazard. This would be a certainty through fouled valve seats. This hazard fortunately is somewhat reduced since the advent of the prepurge cycle incorporated in combustion control relays. However, this purging is not too thorough, especially on LP gas and heavy oil fumes in a natural draft job. Periodic flushing of strainer baskets and oil and gas solenoid seals is essential in preventing debris from lodging on these valve seats.

Preventive maintenance on controls will also eliminate the dangerous practice of operators forced to fire their equipment with bypassed combustion controls in an emergency because of a neglected control.

A. F. JELENC
Sales Engineer
Ace Engineering Co.

New . . . REMPE "Hi-Cap" STEAM HEATING COILS WITH DEFROSTER

For Use In Combination With Air Conditioning Coils Or As Tempering and Booster Units in Long Heating Ducts.



Available in Single Row Type with BTU per hour capacity from 60,000 to 360,000. In Double Row Type, for heavy duty service, in capacities from 129,000 to 775,000 BTU per hour. Heavy gauge steel casings. Copper tubes and headers. Tested 350 lbs. air pressure for steam working pressures up to 125 lbs. Defroster-standard equipment. Also suitable for hot water.

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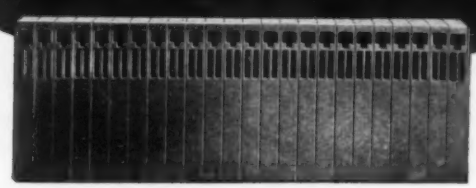
Your job will be a lot easier if you'll keep the January Directory issue of Heating, Piping & Air Conditioning constantly available for handy reference. It's one of your most valuable tools — one which will save you many hours of looking up the products you need for your various jobs. It's the ONE complete, up-to-date, readily accessible source of product information on who makes the pumps, valves, traps, compressors, specialties of all kinds, etc., you need — and where they're located. They're identified by trade names, too. EVERY product is listed, alphabetically arranged and printed on a distinctive yellow stock for easy reading and reference. Keep it handy . . . it's a time saver.

specify SHAW
RADIATORS
for perfect heating comfort



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and other applications which HAVE proved that this modern method of snow removal

Costs No More Than Other Methods

—and because snow melting by pipe coils has other distinct advantages, such as dirt-free sidewalks and entrances, and the complete elimination of ice surfaces, the demand for this method of snow removal is swiftly growing.

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It can be used in any space heating control circuit in any type of building where lowered night or weekend temperatures are desired.

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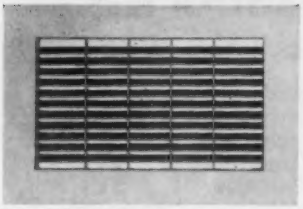

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MEETINGS & CONVENTIONS

SEPT. 12-16—*Instrument Society of America,* 10th annual conference and exhibit. Shrine Exposition Hall and Shrine Auditorium, Los Angeles. Show office: 3443 S. Hill St., Los Angeles 7.

SEPT. 12-16—*Corrosion Short Course.* Washington Univ., St. Louis. Sponsored by: National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2.

OCT. 27-28—*National Conference on Industrial Hydraulics,* 11th annual meeting. La Salle Hotel, Chicago. Sponsored by Illinois Institute of Technology and Armour Research Foundation, 35 W. 33rd St., Chicago 16.

NOV. 1-5—*World Symposium on Applied Solar Energy.* Westward Ho Hotel, Phoenix. Subjects to be discussed are space heating and cooling with solar energy, solar water heaters, mechanical energy from solar energy, direct conversion of solar energy and others. Symposium is cosponsored by the Association for Applied Solar Energy and Stanford Research Institute, Stanford, Calif.

NOV. 14-17—*2nd International Automation Exposition.* Navy Pier, Chicago. Exposition headquarters is at 845 Ridge Ave., Pittsburgh 12.

NOV. 14-18—*Chicago Exposition of Power & Mechanical Engineering.* Coliseum, Chicago. The exposition is being held in conjunction with the 75th Anniversary Meeting of the American Society of Mechanical Engineers. Management: International Exposition Co., Inc., 480 Lexington Ave., New York 17.

NOV. 28-*DEC.* 1—*9th Exposition of the Air Conditioning and Refrigeration Industry.* Auditorium, Atlantic City. The exposition is sponsored by the Air Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N. W., Washington, D. C.

DEC. 1-3—*American Society of Refrigerating Engineers,* 51st annual meeting. Traymore Hotel, Atlantic City. R. C. Cross, secretary, 234 Fifth Ave., New York.

DEC. 10-17—*Nuclear Congress and Atomic Exposition.* Municipal Auditorium, Cleveland. American Institute of Chemical Engineers is the sponsor. Exposition director: Athel F. Denham, Atomic Exposition, 931 Book Bldg., Detroit 26. Concurrently will be held the *Nuclear Engineering and Science Congress,* December 12-16. Engineers Joint Council, 29 W. 39th St., New York 18.

JAN. 23-25—*American Society of Heating & Air-Conditioning Engineers, Inc.,* annual meeting. Sheraton-Gibson Hotel, Cincinnati. ASHAE headquarters: 62 Worth St., New York 13.

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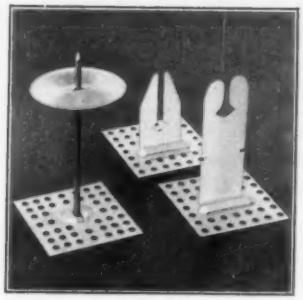

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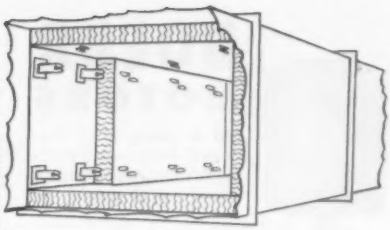

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New COOK all-aluminum belt-drive centrifugal ventilator

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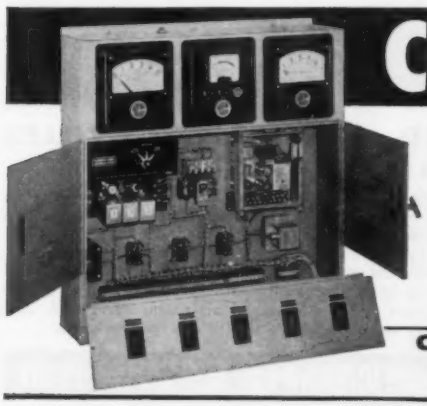

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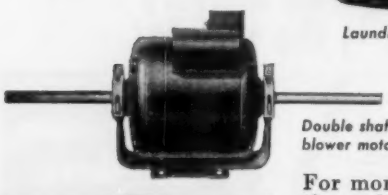

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Electric Motors from 1/30 to 5 hp. Standard, or designed to your specifications.

NEW BOOKS & REPORTS...

THERMODYNAMICS—By John Francis Lee and Francis Weston Sears. 543 pp. Addison-Wesley Publishing Co., Inc., Cambridge 42, Mass. $7.50.

1950-1951 BIBLIOGRAPHIC SURVEY OF CORROSION—430 pp. National Assn. of Corrosion Engineers, 1060 M & M Bldg., Houston 2. $12.50. ($10.00 to NACE members.)

APPLIED THERMODYNAMICS—Third Ed. By Earle B. Norris, Eric Therkelsen and Clarence E. Trent. 490 pp. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. $7.50.

EVERYTHING *AND* THE KITCHEN SINK—160 pp. The story of progress and its makers during the past century. Profusely illustrated. Crane Co., 836 S. Michigan Ave., Chicago 5. $4.00.

REFERENCE TABLES FOR THERMOCOUPLES—National Bureau of Standards Circular 561. 84 pp. U. S. Government Printing Office, Washington 25. 50c.

TENTATIVE SPECIFICATIONS FOR LOW ALLOY STEEL ARC-WELDING ELECTRODES — Issued jointly by the American Welding Society and the American Society for Testing Materials. Copies from AWS, 33 W. 39th St., New York 18. 40c.

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LOW VELOCITY UNIT COOLER FOR FOOD PROCESSING & STORAGE

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Designed especially to conserve space, maintain proper temperature, produce even air motion, and reduce shrinkage. COLDMASTERS are ideal for multiple-unit installations. Available for ammonia, or for Freon, in galvanized or stainless steel.

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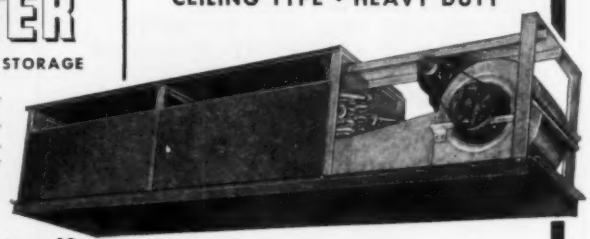

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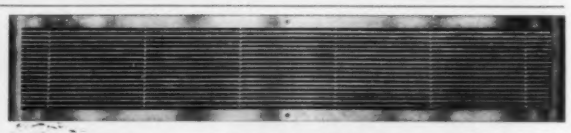

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for

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Thoroughly experienced in original development of thermostatic and electro-mechanical control devices. Familiarity with AGA, NEMA and UL Requirements desirable. Permanent addition to present staff, civilian projects. Send complete resume, salary expected, to Mr. H. G. Wright, West Coast Research & Development Laboratory.

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Manufacturer's Representatives, sales engineering. Two new specialties for wide application in piping field. Markets: equipment manufacturers and jobbers in heating and industrial piping. All territories open. Complete replies desired. Address Key 1172A, Heating, Piping & Air Conditioning, 6 North Michigan Avenue, Chicago 2, Illinois.

situation wanted . . .

MECHANICAL ENGINEER — 18 years experience heating, piping, air conditioning, and plumbing design and construction. Recently Chief Engineer & Director of Purchasing with national Mechanical contractor. 42 years old, married, children; will relocate. Address Key 1177A, Heating, Piping & Air Conditioning, 6 North Michigan Ave., Chicago 2, Ill.

patents . . .

INVENTORS AND MANUFACTURERS: Patentability Searches. Practice before the United States Patent Office. Invention Record and Patent Information Booklet free on request. Franklin W. Durgin Registered Patent Agent, 410 Hill Building, Washington 6, D. C.

situations open . . .

PROJECT ENGINEER — A large, well known manufacturer of heating and air conditioning equipment who is expanding its engineering staff and facilities, has an opening for a man qualified to assume design responsibility on gas and oil-fired residential heating equipment. Located near Chicago. In responding, include a resume of experience, background and salary requirements. Our organization knows of this advertisement; all replies will be held in strictest confidence. In replying, please write to Key 1178A, Heating, Piping & Air Conditioning, 6 North Michigan Ave., Chicago 2, Illinois.

WANTED — Chief Engineer — Wonderful opportunity for advancement with fast-growing aggressive manufacturer of fans and blowers. Will be in complete charge of design and development. Excellent opportunity for creative engineer. Plant located in progressive, modern, Midwest community. Staff knows of this ad. State experience and qualifications first letter. Reply to Key 1157A, Heating, Piping & Air Conditioning, 6 North Michigan Avenue, Chicago 2, Illinois.

WANTED: DISTRICT SALES MANAGER, Eastern Seaboard, by an old established midwest manufacturer of regulating valves. We sell in the low pressure industrial field mostly through plumbing and heating jobbers but we require good practical knowledge of application engineering as well as sales acquaintance. Salary and bonus. Address L.G.L. Thomas, P. O. Box 6910, North Philadelphia Station, Philadelphia 32, Pa.

MIDWEST MANUFACTURER has an opening for an application specialist to report to sales manager of cooling equipment. Should have actual experience in application of comfort cooling equipment. Some travel. Will assist distributors and dealers in establishing application practices. Assist in preparing installation manuals and conduct training programs. Our employees know of this ad. Send complete resume of education, experience, salary, etc. to Key 1179A, Heating, Piping & Air Conditioning, 6 North Michigan Ave., Chicago 2, Ill.

ENGINEERS needed for well established office with high grade clientele. Need men with actual design experience in mechanical or electrical work for buildings. Air Conditioning designers expecially needed. Excellent prospects for right man. Address Key 1173A, Heating, Piping & Air Conditioning, 6 North Michigan Avenue, Chicago 2, Illinois.

MECHANICAL ENGINEER—Long established architectural and engineering firm in northwestern Ohio needs registered engineer for design and specification writing in plumbing, heating, ventilating and air conditioning. Work is mostly public and commercial buildings. Mail details of education, experience, etc. Address Key 1180A, Heating, Piping & Air Conditioning, 6 North Michigan Avenue, Chicago 2, Illinois.

Exceptional opportunity for a sales-minded engineer (26 to 40) with oil burner experience. To assist Sales Manager in contacting major oil burner manufacturers and service organizations nationally from Home Office at Des Moines. Duties include sales engineering, service and extensive field sales promotion work. Salary and travel expenses with excellent chance for advancement in growing company. Your reply kept confidential. Write or call Director of Sales, Delavan Manufacturing Company, Grand Avenue and 4th, West Des Moines, Iowa. Phone 7-4471.

lines wanted . . .

REPRESENTATION AVAILABLE—Northern California Mfr's Repr. wants one additional major account in Htg. Vtlg. or Air Cdtg. Prefers line presently active where desire for change exists both parties, and increased promotion would increase sales. Will give coverage warranted. Thinking of Exhausters, cooling towers, thermal insulated piping, expansion joints. Address Key 1181A, Heating, Piping & Air Conditioning, 6 North Michigan Ave., Chicago 2, Illinois.

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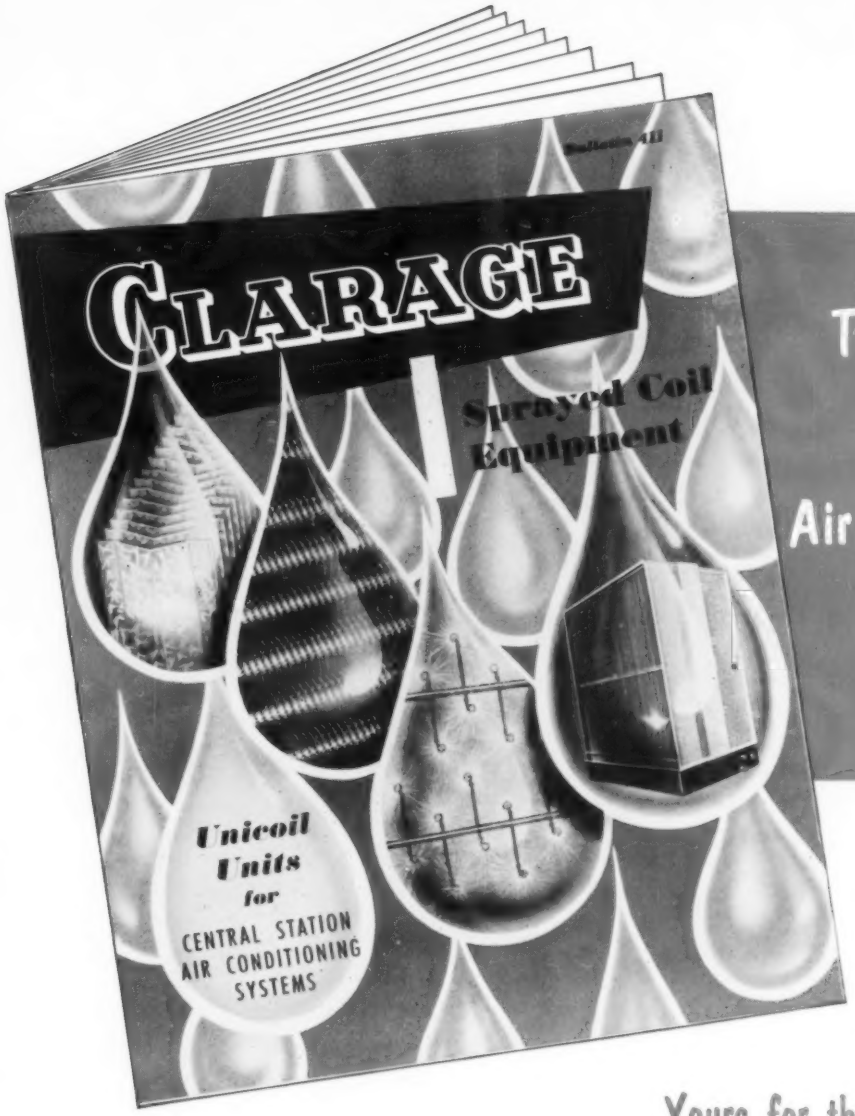

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Most heating men *do* know that McDonnell makes boiler water feeders, low water cut-offs and hot water relief valves.

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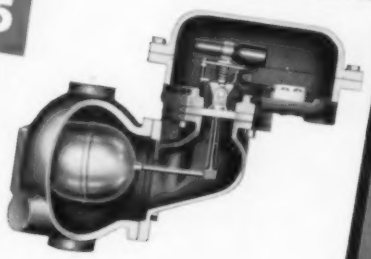
Doing One (M&M SAFETY CONTROLS) *Thing Well*

No. 65

Underwriters' listed

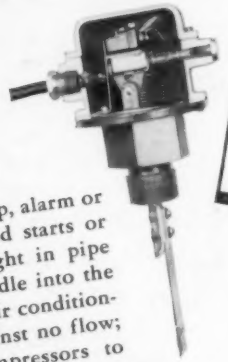
Explosion Proof Electric Controller



A float-operated switch for use under hazardous conditions such as atmospheres containing butane, benzol, lacquer solvent, alcohols, acetone, coal and grain dust, etc. Recent applications include control of gasoline tank levels at Air Force bases. Can be furnished to make or break circuit at high or low level. For internal pressures to 40 lb.

No. E-2

Flow Switch



Serves to start or stop a pump, alarm or meter when flow of a liquid starts or stops. Can be mounted right in pipe line; extends a flexible paddle into the pipe. Is being used on air conditioning systems to guard against no flow; with generators and compressors to assure flow of cooling water; in mixing and blending various liquids; and for many other jobs. For working pressures up to 150 lbs.

Your Jobber Stocks Them

No. 18

Float Valve

Simplest answer yet for hundreds of liquid level control jobs. It is being used on humidifiers, evaporative coolers, coffee urns, fish aquaria, bird baths, etc. Has neoprene valve disc; all other parts are brass or copper. Available also with float arm at right angles for overhead inlet, and with float chamber and cover. Seats tightly against supply pressures up to 100 lbs.

McDONNELL

Boiler Water Level Controls